18th EUROPEAN STUDENT COLLOID CONFERENCE
-
ESC 2022

PROGRAMME & BOOK OF ABSTRACTS

June 26 – 30, 2022
Szeged, Hungary

Magyar Kémikusok Egyesülete
Hungarian Chemical Society

ECIS European Colloid and Interface Society

18th EUROPEAN STUDENT COLLOID CONFERENCE
-
ESC 2022

June 26 – 30, 2022
Szeged, Hungary

Edited by László Mérai and Kadosa Sajdik

Conference logo by Tamás Szabó

Organizers:

Magyar Kémikusok Egyesülete
Hungarian Chemical Society

Published by the Hungarian Chemical Society

ISBN 978-615-6018-12-0

Sponsors and exhibitors:

Sponsors and exhibitors:

Silver sponsor:

2022
Anton Paar
100
1922
YEARS

Sponsors:

MOL

LS Instruments

Continental
SINCE 1871
ContiTech
Szeged

UNICAM
Magyarország Kft.

materials
an Open Access Journal by MDPI

ECIS
European
Colloid and
Interface
Society

Table of Contents

Dear Colleagues!

The European Colloid & Interface Society (ECIS) and the Hungarian Chemical Society (MKE) invite you to participate in the 18th European Student Colloid Conference, to be held at the University of Szeged (USz) in Szeged (H-6720 Szeged, Dóm tér 7-8), Hungary, from 26th to 30th of June, 2022.

After the successful and memorable 2006's ECIS conference in Budapest, this time the Hungarian colloid science society is delighted to welcome the future generation of colloid and interface scientists from all across our continent! However, if your fields of interest seems to be more related to materials science, nanotechnology, or even biotechnology and many areas of physics, this conference still has open doors for you: remember, colloid science is a deeply interdisciplinary field, and you might be surprised how useful it could be to interact and exchange ideas with fellow students and learn from our expert Teacher Team!

ECIS organizes these biannual meetings to motivated students at PhD and MSc level who are undertaking research at a European University, or being in collaborative linkage with European research groups. These meetings are intended for students to present their work to their peers and to promote scientific and social interactions. Apart from the prominent senior teachers, the conference is restricted to PhD students, who have not yet submitted their theses, and to MSc students. Presentations may be either in the form of talks or posters, but oral presentations are usually restricted to students in the later stages of their project. The latest few events, including the European Student Colloid Conference in Varna, Bulgaria (June 2019), attracted around 100 students from more than a dozen countries.

Many students of the University of Szeged and members of the Hungarian Chemical Society are involved in the organization of this meeting. In the name of the whole team, we have high hopes that you will all enjoy a stimulating and fruitful five days during the 18th ESC in Szeged!

Tamás Szabó	István Szilágyi	László Mérai
senior chairman	senior chairman	junior secretary

Organizing Committee

Senior Organizers (University of Szeged):

Tamás Szabó – Senior Chairman

István Szilágyi – Senior Chairman

Senior Organizers (Hungarian Chemical Society):

Beáta Androsits

Beatrix Schenker

Junior Organizers (University of Szeged):

László Mérai – Secretary

Nizar B. Alsharif

Katalin Viktória Bere

Péter Gyenes

Bojana Katana

Péter Nagy

Kadosa Sajdik

Zsófia Árok Mrs Varga

Máté Sütő

Adél Szerlauth

Dóra Takács

European Student Colloid Conference 2022

26th – 30th June, 2022.
University of Szeged, Szeged

Programme

Oral Presentations

Remember that all scientific sessions will be held at Dóm tér 7.

June 26th (Sunday)

Szálka Halászcsárda /6726 Szeged, Közép Kikötő sor 9/A./

17:00 - 18:00 **Registration**
18:00 - 20:00 **Welcome reception**

June 27th (Monday)

Albert Szent-Györgyi Lecture Room (1st floor)

08:00 – 08:45 **Registration**
08:40 – 09:00 **Opening**

Biomedical aspects of colloids / Surfactants, micelles, self-assembly

Chairman: István Szilágyi

09:00 – 10:00	PL-1	**Prof. Marco Lattuada** *From particles, to aggregates and gels...What can we learn about colloidal (in)stability from models and simulations.*

Chairman: Kadosa Sajdik

10:00 – 10:20	OP-1	**Dominik L. Braunmiller,** Susan Babu, David B. Gehlen, Maximilian Seuß, Tamás Haraszti, Andreas Falkenstein, Julian Eigen, Laura De Laporte and Jérôme J. Crassous *3D control of pre-programmable composite microgels for magnetic actuation and tissue engineering*
10:20 – 10:40	OP-2	**Gyöngyi Gombár,** Ditta Ungor, Edit Csapó *Small molecule-stabilized fluorescent gold nanostructures: preparation and structural analysis*
10:40 – 11:00		*COFFEE BREAK in lecture room 123 (1st floor)*

Chairwoman: Bojana Katana

11:00 – 11:20 OP-3 **Adél Szerlauth**, Tamara Madácsy, Árpád Varga, Dániel Sebők, József, Maléth, István Szilágyi
Immobilization of antioxidant enzymes on layered double hydroxide nanosheets to prevent oxidative stress

11:20 – 11:40 OP-4 **Árpád Turcsányi,** Ditta Ungor, Edit Csapó
Utilization of gold nanoclusters and bimetallic silver-gold nanoclusters as fluorescent reporters

11:40 – 12:00 OP-5 **Sotiria Demisli,** Maria Goulielmaki1, Tanja Ilić, Fotios Kyrilis, Farzad Hamdi, Panagiotis L. Kastritis, Frédéric Nallet, Vasiliki Pletsa, Snežana Savić, Aristotelis Xenakis, Vassiliki Papadimitriou
Oil-in-water nanoemulsions versus nanoemulsion-based hydrogels as delivery systems for cannabidiol. Structural study and biological evaluation.

12:00 – 13:30 *LUNCH at Szálka Halászcsárda*

Chairman: Prof. Ladislau Vékás

13:30 – 14:30 PL-2 **Prof. Pál Jedlovszky**
Computer simulation methods in colloid and interface science

14:30 – 15:30 **POSTER SECTION** *& COFFEE BREAK in lecture room 123*

Chairman: Nizar B. Alsharif

15:30 – 15:50 OP-6 **Parth Kadakia,** Stefan Salentinig
Development and characterization of a pH-responsive lipid-based nutrient delivery vehicle

15:50 – 16:10 OP-7 **Smaragda-Maria Argyri,** Lars Evenäs, Romain Bordes
Acoustic levitation and Machine learning to determine surface properties

16:10 – 16:30 OP-8 **Rebeca Fortes-Martín,** Joachim Koetz
Reverse Microemulsions as versatile Soft-Templates for the Surface Assembly of Nanoparticles into Heterostructured Filament Networks

June 28th (Tuesday)

Albert Szent-Györgyi Lecture Room (1st floor)

Please consider that there are two parallel sessions from 14:30.

Chairman: Tamás Szabó

09:00 – 10:00 PL-3 **Prof. Teresa J. Bandosz**
Beyond Adsorption and Because of Adsorption: Exploring the silent aspect of carbon porosity

10:00 – 10:20 OP-9 **Anderson Paiva,** Andrew Jones, Timo Müller, Barbara Puhr, Benedikt Schrode, Praveen Vir
Basics of X-ray diffraction and applications

10:20 – 10:40 OP-10 **Frida Bilén,** Antoine Balzano, Robson Rosa da Silva, Hannes Schomaker, Pernilla Tanner, Paul Erhart, Kasper Moth-Poulsen, Romain Bordes
Machine learning assisted interpretation of UV-Vis spectra of gold nanoparticles

10:40 – 11:00 *COFFEE BREAK in lecture room 123*

Chairman: Prof. Imre Dékány

11:00 – 12:00 PL-4 **Prof. Brian Vincent**
Mimicking Molecular Behaviour with Colloidal Particles

12:00 – 13:30 *LUNCH at Szálka Halászcsárda*

Chairman: Prof. Pál Jedlovszky

13:30 – 13:40 PL-5 **Prof. Piotr Warszyński**
Surfactants; more than heads and tails

Section 1 – Zoltán Szabó Lecture Room (3rd floor)

Colloidal dispersions, foams, emulsions, suspensions

Chairman: Kadosa Sajdik

14:30 - 14:50 OP-11 **Lakshmi Shiva Shankar**, Kun Robert
Preparation of Carbon/Sulphur Nanocomposites by means of Colloidal Heterocoagulation Route for New-Generation Li-S Battery Electrodes

14:50 - 15:10 OP-12 **Viktor Eriksson,** Jules Mistral, Ting Yang Nilsson, Markus Anderson Trojer, and Lars Evenäs
Microencapsulation for controlled release of active substances from fiber materials

15:10 – 16:10 **POSTER SECTION** *& COFFEE BREAK in lecture room 123*

16:10 – 16:30 OP-13 **Borbála Tegze,** Emőke Albert, Adrien Paudics, Miklós Kubinyi, Gyula Tolnai, Balázs Borbás, Zoltán Hórvölgyi
Upconverting nanoparticles and their composite coatings

16:30 – 16:50 OP-14 **Flavio Massignan,** Éva Kiss
Nanoencapsulation of polar bioactive compounds

Section 2 – Albert Szent-Györgyi Lecture Room (1st floor)

Interfacial phenomena and adsorption

Chairman: Péter Gyenes

14:30 - 14:50 OP-23 **Lee Shool,** Alexander V. Butenko, Eli Sloutskin
Apparent Young-violating concave-convex switching of curved oil-water menisci

14:50 - 15:10 OP-24 **Angelo Musicò,** Rossella Zenatelli, Miriam Romano, Andrea Zendrini, Marina Cretich, Chiara Urbinati, Marco Rusnati, Giuseppe Pomarico, Paolo Bergese, Annalisa Radeghieri
Protein Corona and EV surface engineering

15:10 – 16:10 **POSTER SECTION** *& COFFEE BREAK in lecture room 123*

Chairwoman: Zsófia Árok, Mrs Varga

16:10 – 16:30 OP-25 **Tin Klačić,** Klemen Bohinc, Davor Kovačević
Supporting Anion and Heating Effect on Properties of Dry Layer-by-layer Assemblies Containing Poly(allylamine hydrochloride) and Poly(acrylic acid)

16:30 – 16:50 OP-26 **Marta Kalbarczyk**, Aleksandra Szcześ, Zoltan May
Biphasic calcium phosphate (BCP) material originated from avian eggshells: the synthesis and adsorption studies

June 29th (Wednesday)

Please consider that there are two parallel sessions from 10:00 to 10:40 and from 14:30 to 15:30.

Chairman: Prof. Brian Vincent
09:00 – 10:00 PL-6 **Prof. G. Julius Vancso**
Smart memory hydrogels for function

Section 1 – Zoltán Szabó Lecture Room (3rd floor)

Colloidal dispersions, foams, emulsions, suspensions

Chairwoman: Dóra Takács
10:00 – 10:20 OP-15 **Giovanni Russo,** Marco Lattuada
Synthesis of Non-spherical Polymer Particles Using the Activated Swelling Method

10:20 – 10:40 OP-16 **Meron Debas,** Rafael Freire, Stefan Salentinig
Design of CO_2-resposive nanomaterials with potential for triggered drug delivery

10:40 – 11:00 *COFFEE BREAK in lecture room 123*

Chairman: Péter Nagy
11:00 – 11:20 OP-17 **Kata Dorbic,** Marco Lattuada
Synthesis of polymeric particles with multiple lobes

11:20 – 11:40 OP-18 **Katalin V. Bere,** István Szilágyi
Modelling the colloidal behavior of nano-sized particles in natural waters

11:40 – 12:00 OP-19 **Klaudia Skorzewska,** Luc Girard, Pierre Bauduin
Superchaotropic flotation: an innovative method and a new concept for the extraction and separation of ions by foams.

12:00 – 13:30 *LUNCH at Szálka Halászcsárda*

Chairman: Prof. Julius G. Vancsó
13:30 – 14:30 PL-7 **Prof. Ladislau Vékás**
Ferrofluids – ultrastable magnetoresponsive colloidal systems. Properties and some applications

Chairman: Nizar B. Alsharif

14:30 – 14:50 OP-20 **Zeeshan Ali,** Jens-Petter Andreassen, Sulalit Bandyopadhyay
Influence of Iron Oxide Nanoparticles in Silanization Process

14:50 – 15:10 OP-21 **Nico Leister,** Heike P. Karbstein
Coalescence phenomena in double emulsions examined via models with different droplet sizes

15:10 – 15:30 OP-22 **Eleni Galani,** Constantina Chalkiopoulou, Theodora Katsilla, Maria D. Chatzidaki, Aristotelis Xenakis
Preparation and Characterization of emulsions stabilized by Pea and Soy Protein Isolates for the encapsulation of a- tocopherol and squalene.

Section 2 – Albert Szent-Györgyi Lecture Room (1st floor)

Interfacial phenomena and adsorption

Chairman: Péter Gyenes

10:00 – 10:20 OP-27 **Samantha K. Samaniego Andrade,** István Bakos, Attila Farkas, Miklós Mohai, Krisztina László
Effect of GO doping on marine biomass based porous carbon and implications for oxygen reduction reaction

10:20 – 10:40 OP-28 **Eszter Kása,** Ivett Petri, Márton Szabados, Bence Kutus, Pál Sipos
Modified sodalite with O-type additives for efficient removal of basic fuchsine dye from aqueous solutions

10:40 – 11:00 *COFFEE BREAK in lecture room 123*

Chairman: Kadosa Sajdik

11:00 – 11:20 OP-29 **Mirela Evgenieva Encheva,** Xiaomei Li, Hans-Jürgen Butt, Rüdiger Berger, Ellen H. G. Backus
Water Induced Polymer Reorientation at a Polystyrene/Polyacrylic Acid Surface

11:20 – 11:40 OP-30 **Matteo Frigerio,** Stefan Salentini
Phosphate ion triggered modifications of oil/water interfaces

11:40 – 12:00 OP-31 **Adrianna Biedrzycka,** Ewa Skwarek
Physicochemical properties of hydroxyapatite/iron oxide composite surface - zeta potential measurements

12:00 – 13:30 *LUNCH at Szálka Halászcsárda*

Chairman: Prof. Julius Vancsó
13:30 – 14:30 PL-7 **Prof. Ladislau Vékás**
Ferrofluids – ultrastable magnetoresponsive colloidal systems. Properties and some applications

Chairwoman: Zsófia Árok, Mrs Varga
14:30 – 14:50 OP-32 **Bojana Katana,** Dóra Takács, Istvan Szilagy**i**
Halloysite Nanotube Colloids – Ion Specific Effects and Enzyme Immobilization

14:50 – 15:10 OP-33 **Dóra Takács,** Bojana Katana, Istvan Szilagyi
Effect of ionic liquid constituents on the stability of layered double hydroxide dispersions

15:10 – 15:30 OP-22 **László Mérai,** Ágota Deák, László Janovák
Composite coatings with thermoresponsive wetting and visible light photoreactivity

15:30 – 16:00 *COFFEE BREAK in lecture room 123*

16:00 – 16:45 //To Be Announced// programme

19:30 – 21:30 Conference Dinner *at Szálka Halászcsárda*

June 30th (Thursday)

Albert Szent-Györgyi Lecture Room (1st floor)

Polimer solutions, gels and phase behaviour

Chairwoman: Adél Szerlauth
09:00 – 09:20 OP-35 **Zsófia Árok,** Szilárd Sáringer, Coline Bretz, Sándor Puskás, István Szilágyi
Effect of brine on the rheological properties of polymers used in enhanced oil recovery

09:20 – 09:40 OP-36 **Zofia Krasińska-Krawet,** Ewelina Jarek, Tomasz Kruk, Krzysztof Szczepanowicz, Lilianna Szyk-Warszyńska, Łukasz Lamch, Sylwia Ronka, Kazimiera A. Wilk, Piotr Warszyński
Adsorption and aggregation properties of hydrophobically functionalized polyanions

09:40 – 10:00 OP-37 **Péter Márton,** Örs Tamás Nagy, Dorina Kovács, Beáta Szolnoki, János Madarász, Norbert Nagy, Gabriella Stefánia Szabó, Zoltán Hórvölgyi
Permeability of chitin and chitosan nanolayers

10:00 – 10:20 *COFFEE BREAK in lecture room 123*

Chairwoman: Katalin Viktóra Bere
10:20 – 10:40 OP-38 **Alexandra N. Kovács,** Edit Csapó
Protein-polymer complex colloidal carriers: synthesis and optimization

10:40 – 11:00 OP-39 **Nizar B. Alsharif,** Katalin Bere, Gergely F. Samu, Istvan Szilagyi
Biocatalytic Hybrids of Manganese Oxide and Sulfate Latex Particles

11:00 – 11:20 OP-40 **Péter Nagy,** Tamás Szabó, Badrul Mohamed Jan, Rabia Ikram
Potential sources, synthesis methods and industrial applications of waste generated graphene-based nanocomposites

11:20 – 11:50 Awards & Closing Ceremony

11:50 – 13:20 *LUNCH at Szálka Halászcsárda*

13:20 – 14:30 Sightseeing

Poster section

27th June (Monday) 14:30 – 15:30, PP-1 to PP-10
28th June (Tuesday) 15:10 – 16:10, PP-11 to PP-19

The poster section will be held in lecture room 123, on the first floor of Dóm sq. 7.

PP-1 **Owais Abdul Hameed**, Mark Gontsarik, Michael Walch, Stefan Salentinig
Design of antimicrobial protein-lipid complexes: From purification to delivery of antimicrobial peptides derived from cytotoxic T cells

PP-2 **Balázs Borbás**, Borbála Tegze, Adrien Paudics, Miklós Kubinyi, Zoltán Hórvölgyi
Synthesis and Characterization of Upconverting Nanoparticles in Suspensions and Chitosan-Matrix Thin Films

PP-3 **Teona Teodora Borović**, Snežana Papović, Jovana Panić, Nikolett Cako Bagány, Slobodan Gadžurić, Marija Bešter-Rogač, Milan Vraneš
A thermodynamic study: Effect of cationic structure of ionic liquids on their aggregation and micellization properties

PP-4 **Anna Bulátkó**, Miklós Mohai, Krisztina László
Investigation of the surface chemistry of graphene oxide and reduced graphene oxide

PP-5 **Alexandra M. Chiriac**, Ștefania D. Iancu, Andrei Ștefancu, Nicolae Leopold
Chemical interface damping of the surface plasmon resonance of single silver nanoparticles due to amino acid adsorption

PP-6 **Dániel Fülöp**, Éva Kiss, Gergő Gyulai
Interfacial properties of PLGA nanoparticles

PP-7 **Péter Gyenes**, Hala Roumia, Kadosa Sajdik, Alberto Tiraferri, Tamás Szabo
Graphene oxide / bovine serum albumin composite ultrafiltration membranes

PP-8 **Georgiana** Ion, Stefania D. Iancu, Nicolae Leopold
Raman-related effects on carotenoids: a systematic study

PP-9 **Jin Hau Lew**, Omar K. Matar, Erich A. Müller, Myo Thant Maung Maung and Paul F. Luckham
Effect of polymer chemistry on polyacrylamide adsorption onto calcium carbonate

PP-10 Gabriela I. Saavedra Isusi, Miriam Weilandt, Ildi Majollari, **Désirée Martin**, Heike P. Karbstein, Ulrike S. van der Schaaf
Emulsions stabilised with pectin-based microgels: Investigations into the effect of pH and microgel particle concentrations on emulsion stability

PP-11 **Konstantina Matskou**, Berke Kisaoglan, Barbara Mavroidi, Maria Pelecanou, Maria Zoumpanioti, Ilias Matis, Aristotelis Xenakis
Inducing the formation of a colloidal albumin carrier of curcumin

PP-12 **Dmytro Miakota**, Katarína Zakutanská, Peter Kopcanský, Natália Tomašovicová
Memory effect in 5CB liquid crystal based composites

PP-13 **Lea Pašalić**, Danijela Bakarić
Impact of different cations on thermal properties of DPPS and DPPC lipid bilayers

PP-14 **Eva Rütten**, Philipp Schochat, Luzie Allert, Heike P. Karbstein
Influence of mixing stream on droplet coalescence during emulsification in HPH process

PP-15 **Meriem Saadli**, Ahmed Mourran and Jérôme Crassous
Hybrid soft magnetic micro-actuators with thermo-programmable response to the external magnetic field

PP-16 **Kadosa Sajdik**, Tamás Szabó
Monitoring the effect of pH and ionic strength on the interaction between Bovine Serum albumin molecules and graphene oxide nanosheets

PP-17 **Krastina Stefanova**, Vasil Georgiev, Zlatina Mitrinova, Slavka Tcholakova
Effect of addition of glycerol on foamability and antifoam efficiency of low molecular mass surfactants

PP-18 **Máté Sütő**, Gábor Peintler, Tamás Szabó, Kadosa Sajdik
pH-dependent removal of paracetamol from aqueous solutions by nanofiltration

PP-19 **Anna Katalin Vas**, Erzsébet Illés
Graphite oxide/nickel ferrite nanocomposites for magnetic hyperthermia

Plenary Lectures

PL-1 – PL-7

Marco Lattuada: From particles, to aggregates and gels...What can we learn about colloidal (in)stability from models and simulations.

Marco Lattuada[1]
1) Department of Chemistry, University of Fribourg, Switzerland

Colloidal stability is one of the most important features of dispersions of nano-and microparticles alike. Understanding and controlling the physical quantities affecting the stability of colloids has great implications on the processing of dispersions. Avoiding instability is essential whenever the end-product of a process is the suspension itself, while inducing and controlling aggregation and coagulation is necessary in the production of materials from dispersions. In the past decades a wealth of information about the aggregation kinetics of colloidal dispersions under dilute conditions have been obtained, using experimental techniques and simulations alike. Unfortunately, almost all relevant applications of colloidal dispersions involve high concentrations, for which it is more challenging to obtain reliable experimental data. In this presentation, I will show how Brownian Dynamic simulations, including in a realistic fashion all interactions among particles, can be used to extract all those information that are difficult to retrieve from experimental data. These include kinetics, morphological information about the clusters, rheological properties, the formation of gels. Simulations performed at high concentrations, sometimes in the presence of gravity, or of shear forces, can then be used to develop simpler models, based on population balance equations, which are easier to use to make quantitative predictions about the fate of colloidal dispersions.

Prof. Marco Lattuada is a Professor of physical chemistry in the department of chemistry of the university of Fribourg in Switzerland. He obtained his PhD from the ETH in Zurich, and was postdoc at MIT. He then became senior scientist at ETH. Later he joined the Adolphe Merkle Institute at the University of Fribourg, and finally became a permanent faculty of the Department of Chemistry at the University of Fribourg as a professor of physical chemistry.

Pál Jedlovszky: Computer Simulation Methods in Colloid and Interface Science

Pál Jedlovszky[1]
1) Department of Chemistry, Eszterházy Károly University, Eger, Hungary

In the several thousand year long history of science, experimental and theoretical methods have been used in a synergistic way to understand Nature. Experiments report observations of the real system of interest, while these observations are interpreted by means of the theories. Theories use appropriate models instead of the real system to be studied, and apply certain approximations. The validity of the model and approximations can be justified *a posteriori* by a sufficient agreement between the theoretical predictions and experimental observations. The appearance of computers in the mid-20th century opened the way for a third scientific approach, namely computer simulations. Like theories, simulations also work on models of the system to be studied, however, provide experimental-like, approximation-free results on the model systems, allowing also the separate validation of the models and theoretical approximations. A great advantage of computer simulations is that extreme conditions can simply be studied and experimentally not or very hardly available quantities can also be accessed. With the continuous increase of the routinely available computer capacities, meaningful simulation of more and more complex systems became available, thus, nowadays various problems in colloid and interfacial chemistry can also be addressed by computer simulations.

In this lecture several examples of such applications of computer simulations will be presented. The detection of the molecularly rugged, capillary wave-corrugated fluid interface, seen at atomistic resolution is discussed. The determination of the contribution of various molecules, moieties and even entire phases to the interfacial tension, the calculation of adsorption isotherms on solid surfaces, and the interpretation of the peculiarities of bile acid micelles (e.g., the presence of two critical micellar concentrations for these biosurfactants) will be presented as case studies.

Prof. Pál Jedlovszky is Professor at the Department of Chemistry at Eszterházy Károly University in Eger, Hungary, heading the Department of Chemistry and Institute of Chemistry and Physics there. He obtained M.Sc. in Chemistry in 1991 at the Eötvös Loránd University, Budapest, and Ph.D. in 1996 at the Hungarian Academy of Sciences. After a postdoc period in Trento, Italy and New York, USA, he returned to Hungary in 2000, and joined to Eszterházy University in 2009. His research interest covers computer simulation of fluids and interfacial systems.

Teresa J. Bandosz: Beyond Adsorption and Because of Adsorption: Exploring the *silent* aspect of carbon porosity

Teresa J. Bandosz[1]
1) Department of Chemistry and Biochemistry, The City College of New York, New York City, USA

In this talk we would like to provide an insight into our perspectives on the new applications of nanoporous carbons that were inspired by the graphene features and its presence in these carbonaceous materials. A significant advancement to the “new” science of the “old” nanoporous carbons is in their new application such as gas sensing and ORR and CO_2RR catalysis. In these applications both surface chemistry and porosity are crucial factors determining the specific performance. The mechanism of specific processes based on an involvement of porosity will be proposed.

Our inspiration by the science of graphene combined with the comprehensive knowledge of activated carbons surface chemistry, texture, morphology and adsorptive/reactive adsorptive properties directed us to look at carbons from another perspective; from the perspective of nanotechnology. The results obtained by us and briefly addressed here are new and many questions have arisen, and are left unanswered, and many approaches need improvements. One has to take into consideration that explaining the complex phenomena in nanoporous carbons is not easy owing to the combination of the porosity and surface chemistry effects. Practically either one cannot exist without another and they add up to that's specific and unique synergy provided only by these materials. One thing is certainly true: “adventurous” graphene features can be found in nanoporous carbons and they deserve to be explored and used to their full extent.

Prof. Teresa J Bandosz is a Distinguished Professor of the City University of New York/City College. For three years she was associated with Dalian University of Technology in China as a sky scholar/ guest professor. Dr. Bandosz is a Fulbright Senior Scholar (2016/2017). She edited the book “Activated carbon surface in environmental remediation”, and authored 7 US patents and over 420 publications in peer-reviewed journals. Since 2014 she is co-editor of Journal of Colloid and Interface Science.

Brian Vincent: Mimicking Molecular Behaviour with Colloidal Particles

Brian Vincent[1]
1) School of Chemistry, University of Bristol, Bristol, BS8 ITS, U.K.

The phase behaviour of simple molecules is well-established. Depending on the temperature and pressure a given molecular species may be a gas, a liquid or a solid (often a crystal). Phase transitions and phase co-existence may also occur. Triple points and critical points are also well-known features of molecular phase diagrams. The question I want to address is: can such analogous behaviour be demonstrated with dispersions of colloidal particles in a liquid medium? The key to answering this question is control of the interparticle pair potential. For classical, charge-stabilised particles in aqueous media, the DLVO pair potential pertains. This is characterised by an energy *maximum* at a certain separation and, at particle contact, a deep energy minimum. However, molecular interactions conform to the Lennard- Jones potential, with a (shallow) energy *minimum* at a certain separation, and a strong repulsion as close contact is approached. If we are to mimick this behaviour with colloidal particles we need to work with particulate dispersions which show a similar pair-potential.
In this lecture, I will describe three types of colloidal dispersions which comply with this condition:

[1] spherical SIO_2 particles with terminally-grafted C_{18} chains dispersed in aliphatic hydrocarbons, where temperature adjustment or ethanol addition controls the depth of the energy minimum in the pair potential.
[2] poly(NIPAM) microgel particles dispersed in aqueous media. Addition of electrolyte and temperature adjustment now control the depth of the energy minimum.
[3] spherical SIO_2 particles with terminally-grafted C_{18} chains dispersed in cyclohexane to which a non-adsorbing polymer is added.

In cases [1] & [2], van der Waals forces are the significant attractive interactions, whereas in case [3] depletion attraction dominates. In all three cases the analogous liquid-vapour and/or vapour-solid phase transitions and co-existence have been demonstrated, as have, in some cases, the existence of triple points and critical points.

Finally, a short section on modelling molecular adsorption on macroscopic surfaces with colloidal particles will also be demonstrated.

Prof. Brian Vincent is currently both an Emeritus Professor and a Senior Research Fellow in the School of Chemistry at the University of Bristol in the UK. He obtained his first degree and PhD at Bristol also. After a period as a postdoc in the University of Wageningen in the Netherlands, he worked for three years at the international chemical company, ICI, before returning to Bristol as a lecturer in Physical Chemistry. He eventually became the Leverhulme Professor of Physical Chemistry. His research interests span the fields of colloid and polymer science.

Piotr Warszyński: Surfactants; more than heads and tails

Piotr Warszyński[1]
1) Jerzy Haber Institute of Catalysis and Surface Chemistry Polish Academy of Sciences

The description of the adsorption of surfactants at phase boundaries, especially at the liquid/gas interface, is one of the classical problems of surface chemistry. More than a hundred years ago, in 1908, Professor Bohdan Szyszkowski developed an equation linking the surface tension of a surface-active substance solution to its concentration by studying the surface tensions of aqueous solutions of fatty acids (C3 to C6), now known as the Szyszkowski equation.

$$\gamma = \gamma_0 - B \ln\left(1 + \frac{c}{A}\right)$$

Since then, many surfactants have been introduced, both natural and synthetic, with a much more complex molecular structure, and their global production is estimated at 15 million tons per year. The theoretical description of surfactant adsorption has also advanced, and many adsorption models have been proposed.

The basic criterion for classifying surfactants is their charge - we divide them into non-ionic, anionic, cationic and zwitterionic. However, the molecular structure is just as important. Typical surfactants have a simple structure (one hydrophobic “tail’ - one hydrophilic "head"), but more complex surface active molecules are nowadays synthesized. That includes surfactants with two hydrophobic chains - one hydrophilic moiety (two-tail surfactants), one hydrophobic chain with more than one hydrophilic moiety, a bolamphiphilic structure containing two hydrophilic moieties located at opposite ends of the hydrophobic chain, gemini surfactants (twin or dimeric), containing two hydrophilic groups and two alkyl chains, trimeric, dendritic or polymeric surfactants. In addition to the structure itself, an important role in the surface activity of surfactants plays counterions of ionic surfactants or the type of functional groups by which individual parts are connected. The complexity of the structure of surfactants makes it necessary to use a molecular approach, for example, using quantum-mechanical methods or molecular dynamics, to understand the mechanism of their surface activity. In the lecture, some examples will be presented that illustrate the necessity to apply this type of approach.
demonstrated.

Prof. Piotr Warszynski (*Piotr.warszynski@ikifp.edu.pl*) is a professor of physical chemistry in the Jerzy Haber Institute of Catalysis and Surface Chemistry, Polish Academy of Sciences (ICSC), Kraków, Poland. He obtained his PhD from the Institute of Physical Chemistry in Warsaw, he was a post-doc at McGill University, Montreal, Canada and then joined the ICSC. Since 2008 he has been a full professor. At present he is the Director of ICSC.

G. Julius Vancsó: Smart memory hydrogels for function

G. Julius Vancso[1]
1) University of Twente, Enschede, The Netherlands

Stimulus responsive polymer hydrogels may exhibit several phases in response to small variations of environmental variables like temperature (T) and pH with strikingly marked hysteresis and volume expansion differences. The structure, dimensions and phase parameters depend on the pathways of varying T or pH, i.e. these systems show a non-ergodic behavior [1]. In this presentation we first provide an overview of the relevant literature, with focus on volume-phase transitions. Then we shall target the synthesis and structure property relations of a novel, dual-responsive organometallic poly(ionic liquid) (PIL), consisting of a poly(ferrocenylsilane) backbone of alternating redox-active, silane bridged ferrocene units, and tetraalkylphosphonium sulfonate moieties in the side groups [2]. This PIL is redox responsive due to the presence of ferrocene in the backbone, and also exhibits a lower critical solution temperature (LCST)-type thermal responsive behaviour. As the polymer can be readily cross-linked and is easily converted into hydrogels, it represents a new dual-responsive materials platform (T and redox). These hydrogels show a non-ergodic behavior and display unusual, strongly hysteretic volume-phase transitions indicating useful thermal and redox memory properties. Possible applications as memory materials and electrical switches will be demonstrated.

References:
[1] Annaka, M., Tanaka, T. Multiple phases of polymer gels *Nature*, 355 (1992) 430-432
[2] Zhang, K., Feng, X., Ye, C., Hempenius, M.A., Vancso, G.J. Hydrogels with a Memory: Dual-Responsive, Organometallic Poly(ionic liquid)s with Hysteretic Volume-Phase Transition Journal of the American Chemical Society, 139 (29) (2017) 10029-10035

Prof. G. Julius Vancso is Professor of Materials Science and Technology of Polymers at the University of Twente in the Netherlands. He obtained his PhD from the Eötvös Loránd University and the Hungarian Academy of Sciences in Budapest. He was postdoctoral fellow and lecturer at the Swiss Federal Institute of Technology (ETH Zürich), and Associate Professor of Physical Chemistry of the University of Toronto until his current employment. He is External Member of the Hungarian Academy of Sciences, and CEO of his startup company SULIS Polymers B.V.

Ladislau Vékás: Ferrofluids – ultrastable magnetoresponsive colloidal systems. Properties and some applications

Ladislau Vékás[1]
Laboratory of Magnetic Fluids, Center for Fundamental and Advanced Technical Research, Romanian Academy-Timişoara Branch, Timişoara, Romania

Ferrofluids or magnetic (nano)fluids are ultrastable magnetoresponsive colloidal systems which manifest simultaneously fluid and magnetic properties. Among the first attempts to achieve this ambitious goal was the patent filed in 1963 by Steven Papell of NASA, who used long term ball milling of a mixture of large particles of magnetite (Fe_3O_4), carrier liquid and a surfactant to obtain a magnetizable liquid rocket fuel. Their magnetically controllable and tunable feature proved to be from the beginning an extremely fertile ground for a wide range of engineering applications. World interest in ferrofluids was highly stimulated by the first commercial application of ferrofluids, the leakage-free rotating seals, an excellent component of recent many high-tech devices from semiconductor industry to space technology. High fidelity moving coil speakers with magnetic fluid damping and cooling demonstrated another highly successful commercial development, now an everyday presence in audio equipment of cars and consumer electronics products. Due to continuous progress in science of magnetic fluids, these proved to be today fully involved in nanotechnology contributions to industrial progress and development of smart devices, all improving every one's quality of life. More recently, intensive researches concerning biocompatible ferrofluids-bioferrofluids-are fully motivated by the day-by-day increasing interest for their applications in biotechnology and nanomedicine.

This lecture offers a brief overview of the most relevant results on ferrofluid synthesis, advanced characterization and ferrohydrodynamics, as well as on the most important interfacial phenomena and flow properties. Finally, it provides a short overview of recent advances in tunable and adaptive multifunctional materials (magnetic microgels and membranes, nano-micro structured magnetorheological fluids) derived from ferrofluids, droplet technology, magnetic targeting of functionalized nanocomposite particles, leakage-free rotating seals, semiactive magnetorheological torque converters and seismic dampers.

Prof. Ladislau Vékás is the director (2009-) of the Center for Fundamental and Advanced Technical Research from Timisoara of the Romanian Academy. He was among the founders of the Laboratory of Magnetic Fluids from Timisoara in 1975 at the Polytechnic University of Timisoara and from 1991 to 2008 he was the head of this laboratory. He acted as responsible/coordinator of over 50 multi-annual national and international research projects. His current research interest refers to synthesis, manifold characterization of ferrofluids, magnetorheological fluids and magnetic nanocomposite particles; ferrofluidic rotating seals, magnetorheological brakes, clutches and seismic dampers. Sealing ferrofluid and nano-micro magnetorheological fluid manufacturing and leakage-free magnetic fluid rotating seal technology were transferred and up-scaled at ROSEAL Co. (Odorheiu Secuiesc, Romania). Dr. Vékás is member of the International Steering Committee of Magnetic Fluids and also of the Editorial Boards of Romanian Reports in Physics, Proceedings of the Romanian Academy, series A, and Magnetochemistry (MDPI). He is member of the Romanian Academy and of the European Academy of Sciences and Arts (Salzburg). Publications: over 200 papers in peer reviewed journals and conference proceedings; 2 books, 8 book chapters; a great number of talks at national and international conferences, symposia and workshops; he is also co-author of 15 patents in the field of ferrofluids and applications.

Oral Presentations

OP-1 – OP-40

Dominik Braunmiller: 3D control of pre-programmable composite microgels for magnetic actuation and tissue engineering

Dominik L. Braunmiller,[1] Susan Babu,[2,3] David B. Gehlen,[2] Maximilian Seuß,[2] Tamás Haraszti,[2,3] Andreas Falkenstein,[1] Julian Eigen,[1] Laura De Laporte [2,3] and Jérôme J. Crassous[1]
1) RWTH Aachen University, Institut für Physikalische Chemie, Aachen, Germany
2) DWI Leibniz-Institut für Interaktive Materialien, Aachen, Germany
3) RWTH Aachen University, Institut für Technische und Makromolekulare Chemie, Aachen, Germany

Microscale anisotropic building blocks have been receiving increasing attention in respect to their use as model systems to study complex phase diagrams, dynamics and self-assembly processes and for their biomedical applications. Tissue engineering is one of them, where rod-like magnetic microgels loaded with superparamagnetic iron oxide nanoparticles (SPIONs) were found to direct cell growth when aligned under a homogeneous magnetic field [1].

We are currently aiming at controlling the magnetic orientation and actuation of such microgels using ferrimagnetic maghemite spindles as anisotropic magnetic fillers instead of SPIONS [2]. Polyethyleneglycol based rod-shaped microgels were produced using particle replication in non-wetting templates (PRINT). The maghemite spindles were pre-aligned and self-assembled into dipolar chains during the microgel synthesis as evidenced by the examination of the resulting composite microgels through scanning electron microscopy (SEM) (Figure 1A). This procedure allows us to pre-program the orientation of the composite microgels parallel or perpendicular to the applied magnetic field as shown in Fig. 1B,C. The actuation of these systems by an external rotating magnetic field further offers the possibility to dynamically align the microgel rods with an orthogonal magnetic moment in the third dimension (Figure 1D). This strategy can be extended to more complex shapes and its application for the design of magnetic micro-actuators. When embedded in Anisogels for cell culture, cell growth can be directed in the direction of the pre-programmed microgel rods. (Figure 1E).

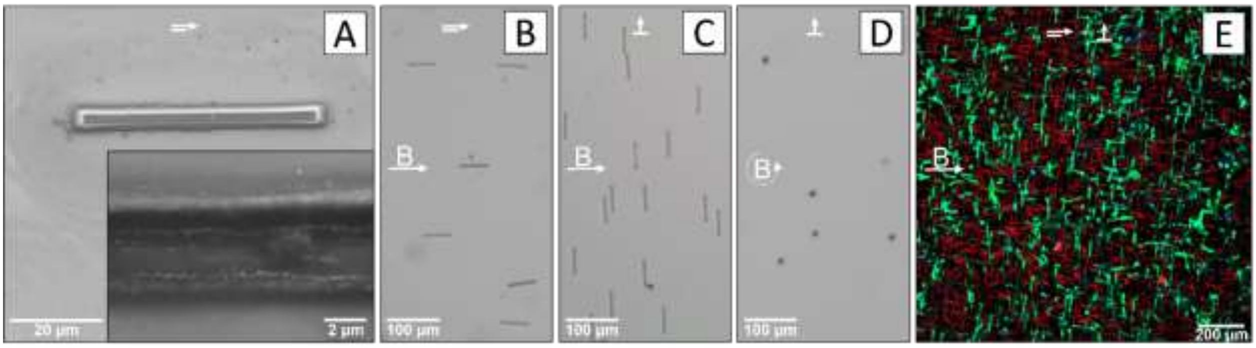


Figure 1. (A) SEM image of incorporated maghemite nanoparticles inside a rod-like microgel. (B,C) Bright field micrographs of the composite microgel alignment parallel and perpendicular to the applied magnetic field. (D) Vertical alignment of the composite microgels with an orthogonal magnetic moment under rotating field (70 mT, 10 rpm). (E) Mouse fibroblast cells growing along parallel and perpendicular aligned rod-shaped microgels

References:
[1] J.C. Rose , M. Cámara-Torres, K. Rahimi, J. Köhler; M. Möller; L. De Laporte, *Nano Letters*, 17 3782 (2017)
[2] V. Malik, A. Pal, O. Pravaz, J.J. Crassous, S. Granville, B. Grobety, A.M. Hirt, H. Dietsch, P. Schurtenberger, *Nanoscale*, 9 14405 (2017)

Dominik L. Braunmiller (*braunmiller@pc.rwth-aachen.de*) is a PhD student in the group of Prof. Jérôme J. Crassous at the Institute for Physical Chemistry at the RWTH Aachen University. He is part of the interdisciplinary Collaborative Research Centre 985 “Functional Microgels and Microgel Systems” of the Deutsche Forschungsgemeinschaft. His research projects mostly involve differently shaped magnetic composite microgels and their behaviour inside magnetic fields. Additionally, he is adapting a custom designed microscopy setup for additional measurement methods trough 3D printing.

Gyöngyi Gombár: Small molecule-stabilized fluorescent gold nanostructures: preparation and structural analysis

Gyöngyi Gombár,[1] Ditta Ungor,[1] Edit Csapó [1]
1) MTA-SZTE Lendület "Momentum" Noble Metal Nanostructures Research Group, Interdisciplinary Excellence Center, Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary

In the last few years, the bioconjugated noble metal nanoparticles are in the focus of attention owing to their remarkable optical properties and high colloidal stability. The Colloids and Nanostructures Research Group, supervised by Dr. Edit Csapó at the Department of Physical Chemistry and Materials Science of the University of Szeged, has been developing gold-containing nanostructured materials for almost 10 years. In recent years, our research focusing on the production of gold-containing nanosized materials that show intense fluorescent properties and can be synthesized without the use of toxic solvents and materials. Using "green chemical" methods the aqueous syntheses can be simplified and the reducing, stabilizing agent can be performed by the same molecule to achieve cost-effectiveness. Therefore, the reduction of precursor aurate ions and the stabilization of the prepared nano-objects are performed by using small molecules.

During my research work, I started the optimization of the synthesis of vitamin B-stabilized gold nanoclusters. The synthesis method involves the investigation of the effect of the key experimental parameters (*e.g.* molar ratio of reactants, temperature, pH, metal ion concentration, synthesis time) on the formation as well as the optical and structural features of vitamin B-directed gold nanostructures. Besides the detailed optical and structural characterization antioxidant activity of the nanosized products have also been studied. In my presentation, the above-mentioned results will be planned to demonstrate.

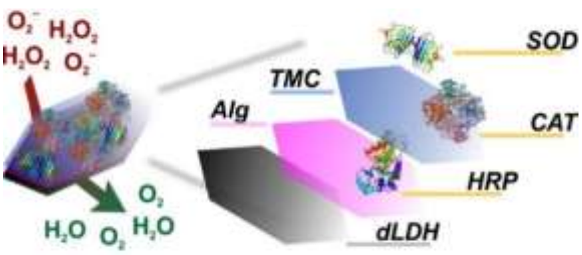
Acknowledgments:
This research was supported by the NRDIO through FK131446 project.

References:
[1] D. Ungor, I. Dékány, E. Csapó, Reduction of Tetrachloroaurate(III) Ions With Bioligands: Role of the Thiol and Amine Functional Groups on the Structure and Optical Features of Gold Nanohybrid Systems, *Nanomaterials* 9(9) 1229 (2019)

I am **Gyöngyi Gombár** (*gygombar@gmail.com*), I am currently pursuing my PhD in Chemistry at the Faculty of Science and Informatics of the University of Szeged. I also completed my basic and master's studies at the University of Szeged. During my studies, the production of polymer-based nanosized drug carrier particles in flow system has been carried out as well as the self-assembly of macromolecules and bioligands has been studied previously by surface plasmon resonance technique. During my PhD studies, I started to deal with the production of gold-containing nanostructured materials, which show intense fluorescent properties and their synthesis can be carried out in a "green chemical" way.

Adél Szerlauth: Immobilization of antioxidant enzymes on layered double hydroxide nanosheets to prevent oxidative stress

Adél Szerlauth,[1] Tamara Madácsy,[2] Árpád Varga,[2] Dániel Sebők,[3] József Maléth,[2] István Szilágyi[1]
1) MTA-SZTE Lendület Biocolloids Research Group, Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary
2) Momentum Epithelial Cell Signalling and Secretion Research Group, Hungarian Academy of Sciences-University of Szeged, Szeged, Hungary
3) Department of Applied and Environmental Chemistry, University of Szeged, Szeged, Hungary



In normal physiological conditions, reactive oxygen species (ROS) are balanced by antioxidants [1]. If such a balance is shifted towards ROS, various diseases may develop in human body or in other living creatures. Antioxidant enzymes are produced to prevent ROS-induced illnesses, but their sensitivity to environmental conditions (pH, radiation, temperature, etc.) hinders their applicability and supplementation. Immobilization or encapsulation in/on carrier materials is a promising tool to eliminate this problem. In our study, three antioxidant enzymes, horseradish peroxidase (HRP), superoxide dismutase (SOD) and catalase (CAT) were immobilized on delaminated layered double hydroxide (dLDH) to achieve sufficient and broad-spectrum ROS scavenging activity, while sodium alginate (Alg) and trimethyl chitosan (TMC) were applied to tune colloidal stability (see scheme for the composition) [2,3]. The immobilization was carried out via the sequential adsorption method, in which electrostatic interactions played a major role and were monitored by electrophoretic light scattering. By analysing the resistance against salt induced aggregation in time-resolved dynamic light scattering, remarkably high critical coagulation concentration was determined indicating the applicability of the composite in electrolyte solutions. Small angle X-ray scattering (SAXS) measurements were performed to explore the formation of polyelectrolyte and enzyme layers and it was found that the surface became diffuse rather than formation of rigid layer-by-layer assembly. The adsorption of enzymes was further confirmed by direct stochastic optical reconstruction microscopy (dSTORM) measurements. By labelling the enzymes with fluorescent dyes, dSTORM measurements proved that after incubation with HeLa cells, the composite penetrated trough the cell membrane without any cellular damage by the nanomaterial. Finally, it was unambiguously proved that the developed hybrid material acts as an effective antioxidant agent and that it was effective in preventing DNA double strand breaking processes. Thus, our composite is a promising tool in ROS scavenging and DNA repairing processes both in biomedical and in industrial applications.

References:
[1] Sz. Muráth, A Szerlauth, D. Sebők, I Szilágyi, *Antioxidants* 9 153 (2020)
[2] A. Szerlauth, E. Balog, D. Takács, Sz. Sáringer, G. Varga, G. Schuszter, I. Szilágyi, *Colloid Interface Sci. Commun.* 46 100564 (2022)
[3] A. Szerlauth, Sz. Muráth, I. Szilágyi, *Soft Matter* 16 10518 (2020)

Adél Szerlauth (*szerlauth.adel@szte.hu*) Adél Szerlauth is a PhD student in the Doctoral School of Chemistry at the University of Szeged. She conducts PhD research in the MTA SZTE Lendület Biocolloids Research Group, where she has been working on the functionalization of delaminated and lamellar layered double hydroxide particles since 2020. In her free time, she likes to read, watch movies, and try out new recipes.

Árpád Turcsányi: Utilization of gold nanoclusters and bimetallic silver-gold nanoclusters as fluorescent reporters

Árpád Turcsányi[1,2], Ditta Ungor[1,2], Edit Csapó[1,2]
1) MTA-SZTE Lendület "Momentum" Noble Metal Nanostructures Research Group, University of Szeged, Szeged, Hungary
2) Interdisciplinary Excellence Center, Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary

In this work we synthesized gold and bimetallic silver-gold nanoclusters (NCs) stabilized with different proteins (bovine serum albumin and lysozyme). Our aim was to use the prepared NCs in fluorescent labeling studies of various nanosized drug carriers (e.g. polysaccharide nanoparticles, liposomes).

The noble metal nanoclusters were prepared using metal precursors ($AgNO_3$, $HAuCl_4$) and proteins (BSA, LYZ) in an aqueous solution under basic conditions (pH=12). The physico-chemical and optical properties of prepared nanoclusters were studied, and their size, size distribution, morphology and colloidal stability were determined by DLS and TEM. The gold NCs possess fluorescence in the red region (around 660 nm) with good intensity, lifetime and quantum yield. The emission maxima were blue-shifted to 600-610 nm in the case of bimetallic NCs with an increase in intensity, using modified synthesis parameters. Structural and elemental composition studies were also carried out using XPS, and the presence and oxidization states of the metals were determined. The labeling process of drug carrier systems was also characterized, investigating their optical stability using fluorimetry and fluorescence microscopy, and their size and colloidal stability were also investigated. The fluorescent labeling experiments resulted in systems with proper colloidal stability, size and excellent optical properties. Comparison of the labeled systems was made based on the type of fluorescent reporter NCs (gold or bimetallic), and also based on stabilizing protein (BSA or LYZ).

Acknowledgements:
This research was supported by the NRDIO through FK131446 and PD137938 projects.

Árpád Turcsányi (*tarpad@chem.u-szeged.hu*) is a PhD student in the Doctoral School of Chemistry of University of Szeged. He has been involved in the preparation and investigation of titanium dioxide and graphite oxide based photocatalysts, synthesis of polysaccharide drug nanocarriers and is currently working on preparation of bimetallic noble metal nanostructures in aqueous conditions and investigation of their structure dependent optical properties. The utilization of such systems as drug and radioactive isotope carriers and also as sensors and fluorescent reporters is included in his studies.

Sotiria Demisli: Oil-in-water nanoemulsions versus nanoemulsion-based hydrogels as delivery systems for cannabidiol. Structural study and biological evaluation.

Sotiria Demisli[1,2], Maria Goulielmaki[1], Tanja Ilić[3], Fotios Kyrilis[4], Farzad Hamdi[4], Panagiotis L. Kastritis[4], Frédéric Nallet[5], Vasiliki Pletsa[1], Snežana Savić[3], Aristotelis Xenakis[1], Vassiliki Papadimitriou[1]
1) Institute of Chemical Biology, National Hellenic Research Foundation, Athens, Greece
2) Department of Biochemistry & Biotechnology, University of Thessaly, Larissa, Greece
3) Department of Pharmaceutical Technology and Cosmetology, University of Belgrade, Belgrade, Serbia
4) Martin Luther University Halle-Wittenberg, Halle (Saale), Germany
5) Centre de Recherche Paul Pascal (CRPP) UMR 5031 CNRS, University of Bordeaux, France

Nowadays, there is an increased interest in alternative therapies for the treatment of various diseases due to the synergistic effect of some natural compounds with conventional drugs. Specifically, cannabidiol (CBD) one of the major phytocannabinoids of the Cannabis Sativa plant extract, is gaining attention since various studies indicate a plethora of pharmacological actions [1]. However, the CBD oil currently available to consumers displays certain disadvantages concerning dosage and bioavailability which varies greatly with route and mode of administration [2]. Although the oral route is one of the most common ways of administration, in the case of CBD, important issues arise such as poor bioavailability and, variable pharmacokinetics profiles [3]. In this sense, it is necessary to consider different routes of administration such as transdermal delivery.

To address the aforementioned issues, biocompatible systems at the nanoscale serving as carriers of bioactive compounds are developed. Nanoemulsions have a special place among them due to their unique physicochemical characteristics. However, nanoemulsions present some limitations such as burst release effect. To that end, in the present study biocompatible, oil-in-water (O/W) nanoemulsions and nanoemulsion-based hydrogels were developed, structurally characterized, and examined *in vitro* and *ex vivo* in terms of CBD release and cytotoxicity.

Structural and biological studies were conducted both in the presence and in the absence of CBD. Using the Dynamic Light Scattering Technique (DLS), the nanodroplet diameter, the polydispersity index, and the stability of the nanoemulsions over time were examined. Confocal (CLSM) and Cryo-Electron (CryoEM) microscopies were also employed for the imaging of the formulated nanodroplets and to determine whether the nanoemulsion is affected by its incorporation into the hydrogel.

Small-angle X-ray scattering (SAXS) was also used to confirm those results. Interfacial properties of nanoemulsions before and after their incorporation in the hydrogels were investigated using Electron Paramagnetic Resonance (EPR) spectroscopy employing amphiphilic spin probes. Both empty and full systems were examined for their *in vitro* cell viability using normal human fibroblasts (WS1) and the colorimetric MTT assay to assess the cell toxicity of the formulated systems both in the presence and absence of CBD. Finally, in order to estimate the potential permeation and retention in the stratum corneum of cannabidiol, an appropriate model was used to simulate human skin. Specifically, an *ex vivo* permeation protocol was performed using modified Franz diffusion cells and porcine ear skin as the model membrane and the quantity of cannabidiol retained in the stratum corneum and the hair follicles of the porcine skin was evaluated by the differential tape stripping method.

References:

[1] Lafaye, G., Karila, L., Blecha, L., & Benyamina, A. Cannabis, cannabinoids, and health. *Dialogues in clinical neuroscience* (2022)
[2] Hazekamp, A. The trouble with CBD oil. *Medical cannabis and cannabinoids* 1(1) 65-72 (2018)
[3] Chen, P. X., & Rogers, M. A. Opportunities and challenges in developing orally administered cannabis edibles. *Current Opinion in Food Science* 28 7-13 (2019)

Sotiria Demisli (*sdemisli@eie.gr*) is a co-supervised PhD student in the National Hellenic Research Foundation and the Department of Biochemistry and Biotechnology at the University of Thessaly. She has been involved in industry-academic collaborative projects concerning the development of novel biocompatible nanodispersions for the encapsulation of natural compounds. Main goal of the formulated systems was the use in various industries including food supplements and, cosmetics. She is always interested in new experiences especially those related to food and travel.

Parth Kadakia: Development and characterization of a pH-responsive lipid-based nutrient delivery vehicle

Parth Kadakia[1], Stefan Salentinig[1]
1) Department of Chemistry, University of Fribourg, Chemin Du Museé 9, 1700, Fribourg, Switzerland

Functional colloids have gained much attention as advanced nutrient delivery systems in the recent years. Their response to external factors such as pH, temperature and ionic strength can be used to trigger nutrient uptake and release [1]. Of particular interest are lipid-based self-assembled structures. In this context, rhamnolipids (RL) are sustainable natural biosurfactants that are extracted from bacteria [2]. However, their self-assembly in water, that is crucial for their further design into functional food materials, has not been analyzed in detail yet.

This presentation demonstrates the pH-dependent phase behavior of RL in buffer. It further discusses the self-assembly of RL with the food-grade surfactant, glyceryl monooleate (GMO) for the design of advanced nutrient delivery systems. Small angle X-ray scattering (SAXS), cryogenic transmission electron microscopy (Cryo-TEM) and dynamic light scattering (DLS) are used in an integrative approach to study colloidal structures and their composition- and pH dependent transformations in solution. RL:GMO dispersions were found to form cubosomes at pH ≤ 5 that reversibly transformed into vesicles at pH ≥ 7 (Figure 1). The further application of the pH-triggered colloidal transformations for controlled release application was demonstrated through the encapsulation and release of a hydrophobic dye Rhodamine B. The results can guide the design of novel nutrient nanocarriers that respond to pH variations in the gastro-intestinal tract. These structures can protect encapsulated degradation-sensitive nutrients or drugs from degradation in the harsh environment of the stomach, and release them at higher pH in the small intestine for absorption into the circulatory system of the body.

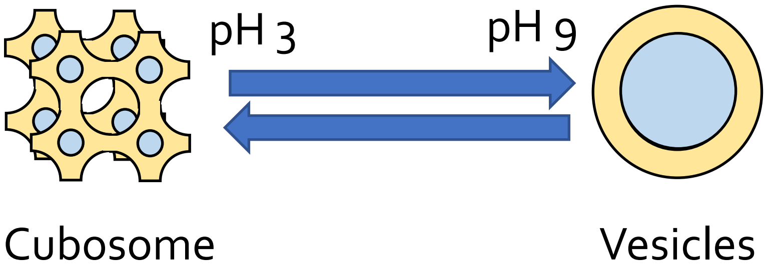


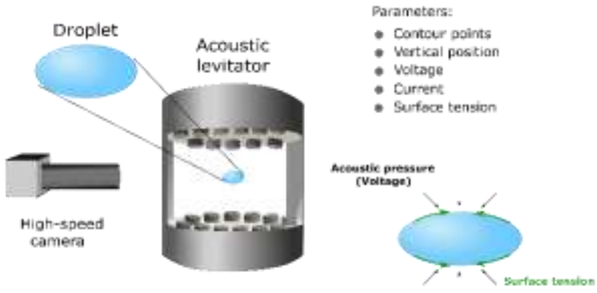
Figure 2. Reversible pH responsive behavior of RL:GMO dispersion

References:
[1] Salentinig, S., Supramolecular structures in lipid digestion and implications for functional food delivery. *Current Opinion in Colloid & Interface Science* 39 190-201 (2019)
[2] Azevedo, M.A., et al., Rhamnolipids-based nanostructured lipid carriers: Effect of lipid phase on physicochemical properties and stability. *Food Chemistry* 344 128670 (2021)

Parth Kadakia (*parth.kadakia@unifr.ch*) is a PhD student in the Biocolloids lab at University of Fribourg, Switzerland. He is a pharmacist who likes to hike.

Smaragda-Maria Argyri: Acoustic levitation and Machine learning to determine surface properties

Smaragda-Maria Argyri[1], Lars Evenäs, Romain Bordes[1]
1) Chalmers University of Technology, Department of Chemistry and Chemical Engineering, SE-412 96 Göteborg, Sweden



Acoustic levitation occurs when at least 2 ultrasonic waves interact in a way that results in local pressure changes in the medium (*i.e.*, air). These pressure differences allow the suspension of samples in the air and the study of single droplet in the microliter regime. That way, surface properties can be studied without the related surface shortcomings. Surface tension is a key surface property of liquids that can be heavily influenced by surface contaminations. Acoustic levitation can address this shortcoming and similarly to the pendant drop method, the surface tension can be determined from its shape, if the pressure applied is known. Apfel *et al.* [1] utilized a Langevin horn and a reflector to levitate liquid samples and mathematically describe the deformation of the samples and determine the surface tension. This led to the development of a model for which experimental accuracy was low (±2 mN/m) in comparison to traditional techniques. One of the underlying reasons was related to the poor stability of the levitating device. Recently, Marzo *et al.* [2] developed a new generation of acoustic levitators that are based on multisource ultrasonic arrays which exhibit higher stability. However, in contrast to Langevin horns, the acoustic field is more complex and challenging to describe. As a result, the previously developed models no longer apply. In our research work, we built a highly stable and compact multisource levitator and monitored the droplet deformation *via* a high-speed camera under varying acoustic pressure. Surfactant solutions have been used to create a large dataset that was then used in a to train a neural network. The resulting algorithm had an accuracy below 1 mN/m. This approach allows the real-time determination of surface tension in a contactless manner, while working with a highly stable levitator.

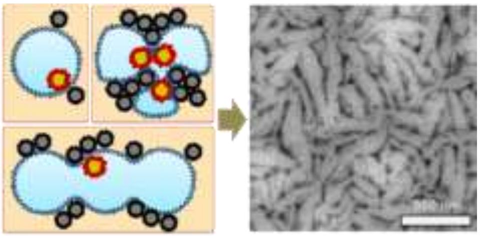
References:

[1] Tian, Yuren, R. Glynn Holt, and Robert E. Apfel. A new method for measuring liquid surface tension with acoustic levitation. *Review of scientific instruments* 66(5) 3349-3354 (1995)
[2] Marzo, Asier, Adrian Barnes, and Bruce W. Drinkwater. TinyLev: A multi-emitter single-axis acoustic levitator. *Review of Scientific Instruments* 88(8) 085105 (2017)

Smaragda-Maria Argyri (*argyri@chalmers.se*) is a PhD student in the Doctoral School of Materials Chemistry of Chalmers University of Technology, in Sweden. She has been involved in projects related to the study of single droplets that are being acoustically suspended in the air. The main objective is to develop methodologies related to the implementation of contactless studies, while studying interfacial phenomena at the air/water interface.

Rebeca Fortes-Martín: Reverse Microemulsions as versatile Soft-Templates for the Surface Assembly of Nanoparticles into Heterostructured Filament Networks

Rebeca Fortes-Martín[1], Joachim Koetz[1]
1) Colloid Chemistry group, Institute of Chemistry, University of Potsdam, Potsdam-Golm, Germany



Current trends in the development of new nanomaterial-based devices often rely on self-assembly processes of nanoparticles. This strategy consists on a bottom-up process as a controlled aggregation into ordered structures, which would combine the individual nanoparticle properties.

A possible approach to mediate the self-assembly upon solvent evaporation is based in the use of soft-templates of thermodynamically stable dispersions. For this purpose, reverse water-in-oil microemulsions were formulated by using Aerosol-OT (dioctyl sodium sulfosuccinate, AOT) as surfactant. Oleyl-capped nanoparticles were incorporated in the continuous oil phase, while polyethylenimine-stabilized nanoparticles were confined in the dispersed water droplets.

The modulation of the microemulsion properties by the different nanoparticle combinations was studied and new forms of self-assembled nanostructures were discovered [1]. For instance, drop- casting and solvent evaporation of the upper water-in-oil phase of a biphasic Winsor type II system over a surface can afford thin films of ordered nanoparticles in filament-like networks [1,2]. Additional characterizations of these systems proved an initial nanoparticle clustering and a microemulsion droplet elongation, which should guide the subsequent formation of the final network of interconnected nanoparticle filaments over a surface [2].

Thus, a new way to use AOT reverse microemulsions as soft-templates of nanoparticles assembly is proved. This enables the hierarchical ordering of spherical nanoparticles into thin films of anisotropic nanostructures, with extended areas above the µm scale. In this way, microemulsions can enable not only nanoparticle synthesis, but also their assembly into larger scale applicability.

References:

[1] R. Fortes-Martín, C. Prietzel, J. Koetz, Template-Mediated Self-Assembly of Magnetite-Gold Nanoparticle Superstructures at the Water-Oil Interface of AOT Reverse Microemulsions, *J. Colloid Interface Sci.* 581 44–55 (2021)

[2] R. Fortes-Martín, A. F. Thünemann, J. M. Stockmann, J. Radnik, J. Koetz, From nanoparticle heteroclusters to filament networks by self-assembly at the water-oil interface of reverse microemulsions, *Langmuir* 37 8876–8885 (2021)

Rebeca Fortes-Martín (*fortesmartin@uni-potsdam.de*) is a PhD student in the Colloid Chemistry group of the University of Potsdam. Their main projects involve the study of nanoparticle interactions and self-assembly at the water-oil interface of reverse microemulsions. Some additional studies include the substitution of nonpolar solvents towards greener alternatives for the formulation of microemulsions, as well as milder methods for the synthesis of nanostructures.

Anderson Paiva: Basics of X-ray diffraction and applications

Anderson Paiva[1], Andrew Jones[1], Timo Müller[1], Barbara Puhr[1], Benedikt Schrode[1], Praveen Vir[1]
1) Anton Paar GmbH, Graz, Austria

X-ray diffraction (XRD) is an analytical technique used to obtain information on material properties such as phase composition, crystal structure, texture, degree of crystallinity, and others. While samples are usually crystalline in nature, the technique is also applicable to amorphous materials. Powders are most commonly used as samples, but solid samples and thin films can also be measured.

X-ray powder diffraction is applied for a wide variety of environments, from process control to R&D. Some of the most relevant applications are:

- Materials Characterization at universities and research centers
- Analysis of phase composition and content for process control in several industries such as chemicals, pharmaceuticals and building materials
- Determination of polymorphism, stability studies and concentration determination in the pharmaceutical industry
- Phase identification in geological samples
- Determination of phase crystallinity
- Determination of amorphous phase contents in mixtures.

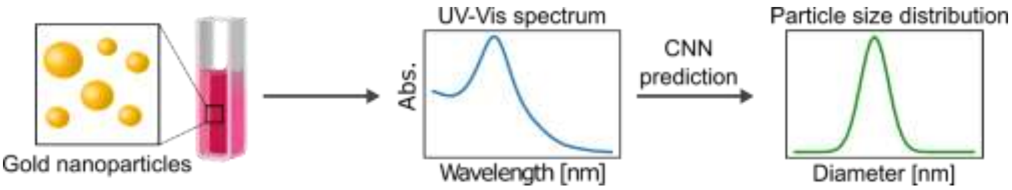
Having many application environments, complex instruments, like powder diffractometers must be enough to handle various demands. A multipurpose powder X-ray diffractometer, like XRDynamic 500, is the ideal solution if you're working in multi-user operation.

References:
[1] A. Pein, B. Puhr[1], A. O. F. Jones, The Non-ambient Guide. First Edition (2018)

Anderson Paiva (*anderson.paiva@anton-paar.com*) is a material engineer and holds an MBA (University of São Paulo – USP), with 10 years of experience in technical sales and product management. He gained deep knowledge in the X-ray instrument market and is currently acting as an X-ray regional sales manager for the Region EMEA at Anton Paar GmbH.

Frida Bilén: Machine learning assisted interpretation of UV-Vis spectra of gold nanoparticles

Frida Bilén[1], Antoine Balzano[1], Robson Rosa da Silva[1], Hannes Schomaker[1], Pernilla Tanner[2], Paul Erhart[2], Kasper Moth-Poulsen[1], Romain Bordes[1].
1) Division of Applied Chemistry, Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Gothenburg, Sweden
2) Division of Condensed Matter and Materials Theory, Department of Physics, Chalmers University of Technology, Gothenburg, Sweden



Flow reactor systems show promise for a high production capacity of metal nanoparticles (MNPs) with well-defined structure and properties [1]. For a fully automated synthesis system where the synthesis conditions are tuned via a feedback loop to give the MNPs the targeted properties, a central feature needed is a quick inline characterization coupled to data interpretation to continuously tune the synthesis parameters [2]. For MNPs, a suitable technique is UV-Vis spectroscopy as surface plasmon bands correlate with structural properties. However, automated spectrum interpretation from single UV-Vis spectra, with regards to detailed information about e.g. size and polydispersity, remains challenging. Our hypothesis is that a machine learning approach using Convolutional Neural Networks (CNNs) can be used to extract MNP structural information from the UV-Vis spectrum by utilizing the ability of this type of model to identify features in complex data [3].

In this work, CNNs have been constructed for predicting size and polydispersity of spherical and rod-shaped nanoparticles from simulated UV-Vis spectra, with and without artificially added noise. The training of the CNNs has been conducted with in-silico generated data and yielded a machine learning framework that accurately predicts properties from a UV-Vis spectrum. It also highlighted that predictions for rod-like particles were more robust against noise than for spherical particles.

By demonstrating that CNNs perform well for feature identification using simulated spectroscopic data, we show that this type of machine learning architecture is promising for further development and integration in the feedback loop of a flow reactor system.

References:

[1] Pekkari, A., et al. *ACS Applied Materials & Interfaces* 11(39) 36196-36204 (2019)
[2] Mekki-Berrada, F., et al. *npj Computational Materials* 7(1) 55 (2021).
[3] LeCun, Y., et al. *Nature* 521(7553) 436-444 (2015)

Frida Bilén (*bilen@chalmers.se*) is a PhD student at the division of Applied Chemistry at Chalmers University of Technology. Her research is centered around the application of machine learning to surface and colloid chemistry, with a special focus on spectroscopic data. She has previous experience from working in the pharmaceutical industry.

Lakshmi Shiva Shankar: Preparation of Carbon/Sulphur Nanocomposites by means of Colloidal Heterocoagulation Route for New-Generation Li-S Battery Electrodes

Lakshmi Shiva Shankar[1], Robert Kun[2]
1) Solid-State Energy Storage Research Group, Institute of Materials and Environmental Chemistry, Research Centre for Natural Sciences, Budapest, Hungary
2) Department of Chemical and Environmental Process Engineering, Budapest University of Technology and Economics, Budapest, Hungary

Li-ion batteries have become prominent over the past two decades, particularly for portable electronics, as they offer a much higher energy density than other rechargeable systems. The current Li-ion technology is based on insertion-compound anode and cathode materials, which limit their charge-storage capacity and energy density. To overcome the charge-storage limitations of the insertion-compound electrode, materials that undergo conversion reactions while accommodating more ions and electrons are becoming a promising option, but are highly challenging [1]. Additionally, more sustainable and more economic materials must be used as electrochemically active components in future batteries.

Sulphur as the positive electrode material possesses a very high theoretical specific capacity of 1672 mAh g^{-1}. Li–S battery technology is considered to be the most viable version of the so-called post-Li-ion battery technology, offering the prospect of cells that supersede the intrinsic limits of Li-ion technology along with the potential for substantially reduced costs, less toxicity and improved safety. However, LiSBs are hampered by challenges across the cell. While the theoretical energy density of Sulphur is 1672 mAh g^{-1}, the actual capacities of cells are inhibited by the poor conductivity of the initial S_8 and final Li_2S components which in turn affects the cycle life performance of the Li-S batteries. Designing carbon/sulphur nanocomposites with optimum tortuosity, microstructure and high sulphur loading are very crucial in fabricating high performing Li-S batteries.

In the current work, we choose a solvent-free, aqueous colloidal heterocoagulation synthesis process to formulate carbon/sulphur nanocomposites for new-generation Li-S batteries. The heterocoagulation process is based on charge neutralization by means of electrostatic attraction between oppositely charged colloidal particles. In our study, an aqueous dispersion of negatively charged graphite oxide (GO) dispersion was combined with positively charged hydrophilic sulphur colloids, called Raffo-type sulphur sol (RaffoS) [2]. The charge equivalent point has been determined by streaming-potential titration and zeta-potential measurements at different GO/RaffoS ratios. The success of the heterocoagulation and the pillaring of the GO lamellae by the intercalated RaffoS particles was verified by XRD analyses. According to our preliminary studies, the proposed heterocoagulation synthesis route could be applicable for the tailored preparation of the electrochemically active carbon/sulphur nanocomposites for future Li-S batteries.

References:
[1] Arumugam. M, Fu. Y, Chung. S. H, Zu. C and Sheng. S.Y, Rechargeable Li-S batteries, Accounts of chemical research. 46, 1125-1134 (2013).
[2] Steudel R, Aqueous Sulfur Sols, Top Curr Chem. 230, 153–166 (2003)

Viktor Eriksson: Microencapsulation for controlled release of active substances from fiber materials

Viktor Eriksson,[1] Jules Mistral,[1] Ting Yang Nilsson,[2] Markus Anderson Trojer,[2] and Lars Evenäs[1,3]
1) Department of Chemistry and Chemical Engineering, Chalmers University of Technology, Gothenburg, Sweden
2) Department of Polymers, Fibers and Composites, Fiber Development, RISE, Mölndal, Sweden
3) Wallenberg Wood Science Centre, Chalmers University of Technology, Gothenburg, Sweden

Chronic and hard-to-heal wounds face a severe risk of infection, and the counteracting treatments often involves antimicrobial substances added to the wound dressing. The conventional surface impregnation of the wound dressing results in an uncontrolled and fast release process, leading to rapid loss of the antimicrobial effect. To control and prolong the release, microspheres loaded with antimicrobial substances are here presented as a solution.

In this study, poly(D,L-lactide-*co*-glycolide) microspheres loaded with the hydrophobic and fluorescent model substance pyrene were formulated and immobilized in fiber materials made from the biobased polysaccharides alginate, cellulose, and chitosan. Nonwoven cellulose fiber materials (Figure 1a) were studied further by evaluating their pyrene release rate in an aqueous solution conditioned to sink behavior. For comparison, two analogous nonwovens were prepared with pyrene either freely dispersed throughout the entire fiber or adsorbed onto the fiber surface.

By fitting geometrically corresponding Fickian diffusion models, the effective diffusion coefficient of pyrene in the materials could be evaluated (Figure 1b). An approximate 100-fold decrease in effective diffusivity was found for the microsphere-functionalized fibers, as compared to fibers containing freely dispersed pyrene. Hence, complete release of encapsulated pyrene was achieved after weeks as compared to only a few hours for both freely dispersed and surface impregnated pyrene. This demonstrates the rate-limiting release barrier functionality provided by the microspheres. Microspheres and microcapsules are not only limited to use in fiber materials and wound care but could for example be further developed for controlled release of antimicrobials in antifouling coatings, or materials in aqua- and agriculture.

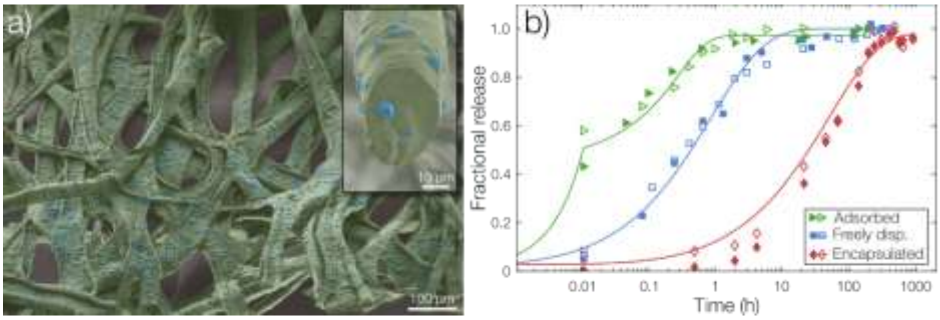


Figure 3. a) Colorized scanning electron micrograph of the cellulose fibers (green) containing microspheres (blue). b) Fractional release from nonwovens with surface adsorbed, freely dispersed, and microencapsulated pyrene, respectively.

Viktor Eriksson (*viktor.eriksson@chalmers.se*) is a PhD student at the Department of Chemistry and Chemical Engineering, Chalmers University of Technology. His research mainly focuses on the formulation of polymeric microparticles, and their subsequently controlled release of active substances like biocides or antimicrobials.

Borbála Tegze: Upconverting nanoparticles and their composite coatings

Borbála Tegze[1], Emőke Albert[1], Adrien Paudics[1], Miklós Kubinyi[1], Gyula Tolnai[2], Balázs Borbás[1], Zoltán Hórvölgyi [1]
1) Budapest University of Technology and Economics, Budapest, Hungary
2) Freelancer scientific advisor, Budapest, Hungary

Upconverting nanomaterials are able to convert multiple photons of lower energy (higher wavelength) into a photon of higher energy (lower wavelength), and due to this property they are promising in many applications. One possibility is to increase the efficiency of solar cells and photocatalyst systems by means of upconversion and dye-sensitization, which allow for a broader wavelength spectrum of solar light to be utilized [1,2]. In a typical example, upconverting nanoparticles (UCNPs) convert near infrared light into visible light, which is absorbed by dye molecules, and then this energy is transferred to a semiconductor material, e.g. TiO_2. Our aim was to investigate these interactions in a thin film model system.

Upconverting $NaYF_4$: Yb, Tm/Er particles (Figure 1) with different compositions were synthesized by solvothermal method, and their properties (shape, size distribution, crystal structure, upconversion emission) were studied. LaF_3: Yb, Tm/Er nanoparticles synthesized with co-precipitation method were also investigated after different heat-treatments. Composite coatings of the UCNPs were prepared on glass substrates with spin-coating method: the chosen matrix materials were SiO_2, TiO_2 and chitosan; single- and multilayered structures were tried. After excitation with 980 nm light, the composite coatings showed emission in the visible and ultraviolet range. The samples were immersed in aqueous solutions of rhodamine 6G dye molecules, and the energy transfer processes between the UCNPs, dye and TiO_2 were investigated by measuring the absorbance and emission spectra during 980 nm irradiation.

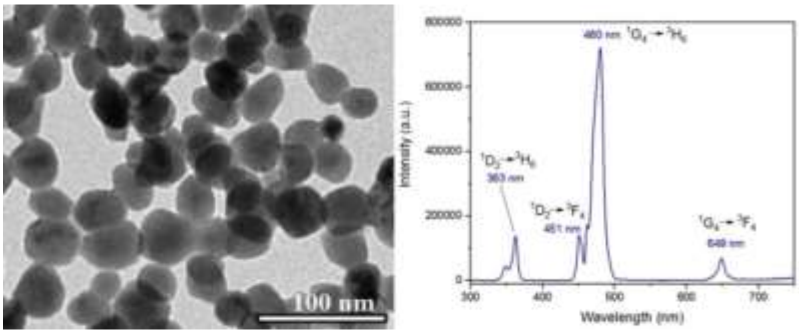


Figure 1. TEM image and upconversion emission of $NaYF_4$: 20% Yb, 0.5% Tm nanoparticles.

References:
[1] W. Yang, X. Li, D. Chi, H. Zhang, X. Liu, *Nanotechnology* 25 482001 (2014)
[2] R. Rajeswari, N. Islavath, M. Raghavender, L. Giribabu, *The Chemical Record* 20(2) 65-88 (2020)

Borbála Tegze (*tegze.borbala@vbk.bme.hu*) did her PhD course as a student of George Oláh PhD school, under the supervision of Prof. Dr. Zoltán Hórvölgyi, and she currently works as an associate research fellow while also finishing her PhD thesis at the Centre for Colloid Chemistry research group at the Budapest University of Technology and Economics in Budapest, Hungary. Her research work includes nanoparticles and sol-gel coatings with photoactive and photoresponsive properties, for example self-cleaning titania surfaces, upconverting nanoparticles and their composites.

Flavio Massignan: Nanoencapsulation of polar bioactive compounds

Flavio Massignan[1], Éva Kiss[1]
1) Laboratory of Interfaces and Nanostructures, Institute of Chemistry, Eötvös Loránd University,
Pázmány Péter sétány 1/A, 1117-Budapest, Hungary

Once a rarely used class of therapeutic agents, pharmaceutical proteins have reached remarkably increasing number and frequency of use. With more than 130 FDA (2012) approved products and many more in development, protein therapeutics have gained a significant role in almost every field of medicine [1].

The presently applied nanoencapsulation systems are designed mainly for hydrophobic drug materials with limited solubility in aqueous environment. The development of efficient and stable carrier systems for proteinous or peptide type drugs presents a challenge and requires a different approach. More complex nanoparticles are thought to fulfill these requirements which include the protection of the bioactive molecule in the various parts of the body, high enough encapsulation efficiency (EE), and particle size lower then 200-300 nm in diameter [2].

The aim of this work is to build a carrier system for proteinous drug allowing its high degree of dispersion, and also providing protection during the administration. First a nanoemulsion (W/O) was prepared, using a combination of two lipids (10MAG/LDAO) as surfactant and PCL in a mixture of appropriate solvents. An average radius of 18 nm was detected using DLS and the aspect was clear and transparent. With the presence of PCL in the nanoemulsion it was possible to use the nanoprecipitation method to obtain particles in water with PVA as stabilizer, a radius of 160 nm was found using DLS, while zeta potential was found to be 45 mV. Lowry assay was used for a quantitative analysis of the protein and revealed an 35% EE. The particles passed an *in vitro* cytotoxicity test [3]. Release properties of the particles were characterized by dialysis which showed that the release starts after an hour and has the maximum around three hours.
It was demonstrated that this encapsulation system is suitable and efficient for proteins/peptides with different sizes and structure, and it is a potential carrier system for other types of drugs as well.

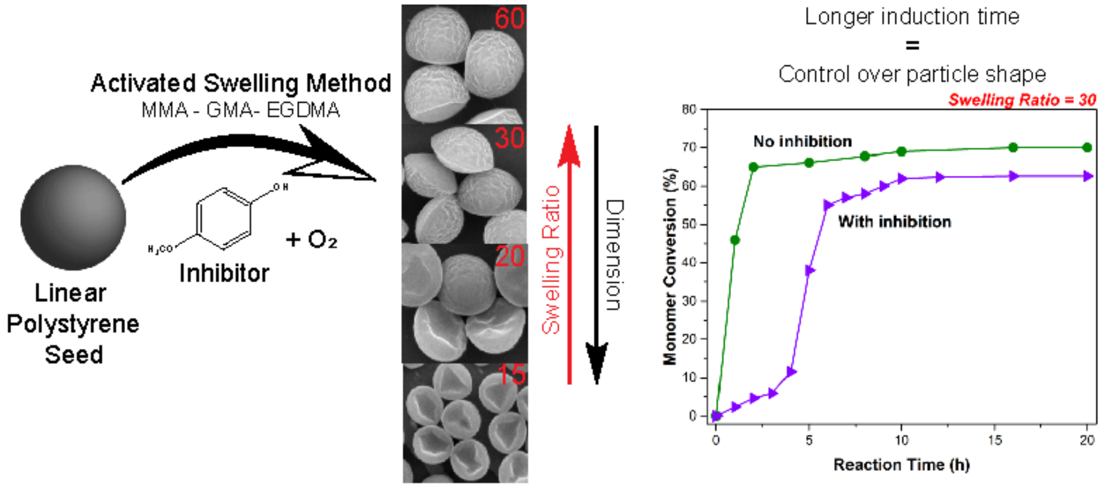
Acknowledgement:
Project no. 2018-1.2.1-NKP-2018-00005 has been implemented with the support provided from the National Research, Development and Innovation Fund of Hungary.

References:
[1] Tina Vermonden, Roberta Censi, and Wim E. Hennink *Chem. Rev.* 112 2853−2888 (2012)
[2] Chris Van der Walle, Peptide and Protein Delivery, Elsevier Inc., London, UK, 2011
[3] Cooperation with MTA-ELTE Lendület "Momentum" Peptide-based Vaccines Research Group, Eötvös Loránd University

Flavio Massignan (*flavio.massignan@gmail.com*) is a PhD student at ELTE university in Budapest, born in Italy and moved in Hungary where he is working in the laboratory of interface and nanostructures, making emulsion for encapsulation of proteins and peptides. In his free time, he likes to capture photons and let them impress a silicon sensor in the way to transform them in memories. He is also an expert in the cultivation of bacteria in the way to let them produce carbon dioxide and get some typical Italian products.

Giovanni Russo: Synthesis of Non-spherical Polymer Particles Using the Activated Swelling Method

Giovanni Russo,[1] Marco Lattuada[1]
1) University of Fribourg, Department of Chemistry, Chemin du Musée 9, Fribourg 1700, Switzerland



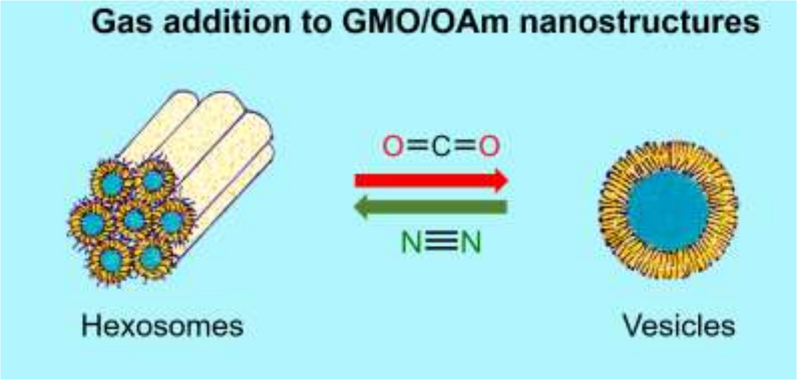
The preparation of particles with non-spherical shapes is a challenging endeavor, often requiring a significant ingenuity, complex experimental procedures and difficulties to obtain reproducible results. In this work[1] we prove that monodisperse non-spherical polymer particles possessing asymmetric Janus structure can be easily produced by using an activated swelling method[2] in combination with a control of the rate of free radical polymerization through the addition of the inhibitors 4-methoxyphenol (MEHQ) and O_2[3,4]. Monodisperse non-cross-linked polystyrene particles, used as seeds, are activated by the addition of an initiator, which promotes their swelling ability, and then swollen with a monomers mixture (methyl methacrylate, glycidyl methacrylate and ethylene glycol dimethacrylate), before being polymerized in presence of both MEHQ and O_2. Our results show that only when both MEHQ and O_2 are present during the course of the polymerization, the particles shape can be controlled, from spherical to asymmetrical. A variety of particles shapes can be obtained, ranging from dimpled spheres, flattened spheres and Janus particles by varying the swelling ratio, always with excellent monodispersity and reproducibility.

References:
[1] G. Russo, M. Lattuada, Synthesis of Non-spherical Polymer Particles Using the Activated Swelling Method, *Journal of Colloid and Interface Science* 611 377–389 (2022)
[2] J. Ugelstad, P.C. Mórk, K.H. Kaggerud, T. Ellingsen, A. Berge, Swelling of oligomer-polymer particles. New methods of preparation, *Adv. Colloid Interface Sci.* 13 (1-2) 101.140 (1980)
[3] S.S. Cutié, D.E. Henton, C. Powell, R.E. Reim, P.B. Smith, T.L. Staples, The effects of MEHQ on the polymerization of acrylic acid in the preparation of superabsorbent gels, *J. Appl. Polym. Sci.* 64 577-589 (1997)
[4] R. Li, F.J. Schork, Modeling of the inhibition mechanism of acrylic acid polymerization, *Ind. Eng. Chem. Res.* 45 (9) 3001-3008 (2006)

Giovanni Russo was born in Palermo (Italy). He received his Bachelor’s degree in 2017 in Chemistry and his Master degree in the same field in 2018 from University of Palermo, working together with Prof. Maria Luisa Saladino (University of Palermo) and Dr. Cristina Giordano (Queen Mary University of London). Since January 2019, he is a Ph.D Candidate at University of Fribourg in the Department of Chemistry under the supervision of Prof. Marco Lattuada. He is currently working on methods for the preparation of monodisperse non-spherical polymer particles by controlling the polymerization kinetics and their application in self-assembly.

Meron Debas: Design of CO_2-resposive nanomaterials with potential for triggered drug delivery

Meron Debas[1], Rafael Freire[1], Stefan Salentinig[1]
1) Department of Chemistry, University of Fribourg, Chemin du Musée 9, 1700 Fribourg, Switzerland



Stimuli-responsive materials can innovate in various fields including food and pharmaceutical sciences. Their response to a specific stimulus can be utilized to release loaded bioactive molecules or sense their presence. The biocompatibility and abundance of CO_2 in the environment makes it an interesting stimulus for such applications.

In this work, the design of CO_2 responsive nanostructured dispersions and their application as delivery platform for hydrophobic molecules is presented. The dispersed lyotropic liquid crystalline phases of glyceryl monooleate (GMO) with the amphiphilic amidine (E)-N,N-dimethyl-N-((Z)-octadec-9-en1-yl)acetimidamide (OAm) were discovered to change structure in presence of CO_2. Their composition- and CO_2 dependent phase behavior was analyzed in detail using small angle X-ray scattering (SAXS), dynamic light scattering (DLS) and cryo-TEM. The further application of the CO_2-triggered colloidal transformations for controlled release application was demonstrated through the encapsulation and release of Rhodamine B. The release rate of the dye was found to change in presence of CO_2 and could be linked with the type of liquid crystalline structure.

The results from this study provides a fundamental understanding of CO_2 triggered functional nanomaterials, and may guide the future design of stimuli-responsive delivery platforms and biosensors.

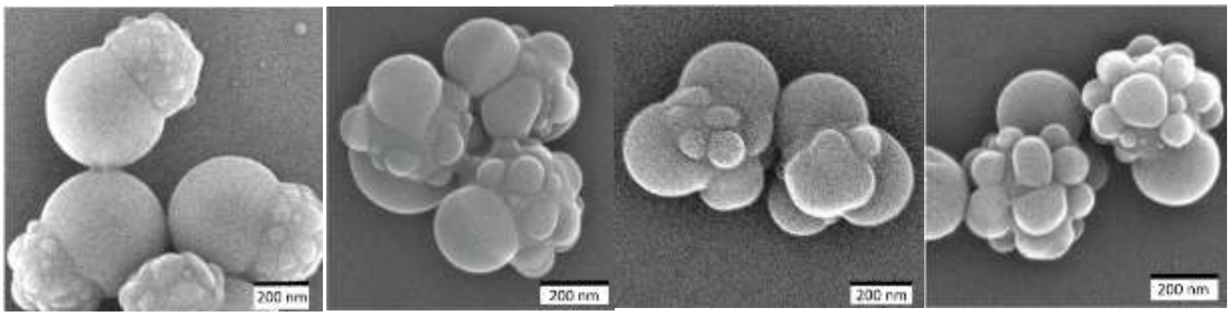
Meron Debas is a PhD student in the biocolloids research group of Prof. Salentinig at university of Fribourg. Her research focuses on lipid-based stimuli responsive nanostructures for their application as antimicrobial peptide delivery system.

Kata Dorbic: Synthesis of polymeric particles with multiple lobes

Kata Dorbic[1], Marco Lattuada[1]
1) Department of Chemistry, University of Fribourg, Fribourg, Switzerland

The formation of particles with multiple lobes has been the focus of several investigations, because of their potential applications as colloidal molecules. Such particles can be used as building blocks in the processes of self-assembly, or they can be used as carriers of different substances because each lobe can be different from the others in the same entity. In the production of multi-lobed particles, it is important to develop protocols that are reproducible and robust, with good yield, and where it is easy to recover the particles at the end of the synthesis.

If one wants to form non-spherical particles, the interfacial tension that drives a particle to adopt a spherical shape must be overcome. Here will be shown how this can be achieved by using a method based on multiple swelling and polymerization steps, starting from simple polystyrene colloids. By combining hydrolyzed 3-(trimethoxysilyl)propyl methacrylate with styrene, with the possibility of introducing a crosslinker, we have been able to induce phase separation. This allowed us to create multi-lobed particles whose morphology changes with the quantity and ratio of monomers.

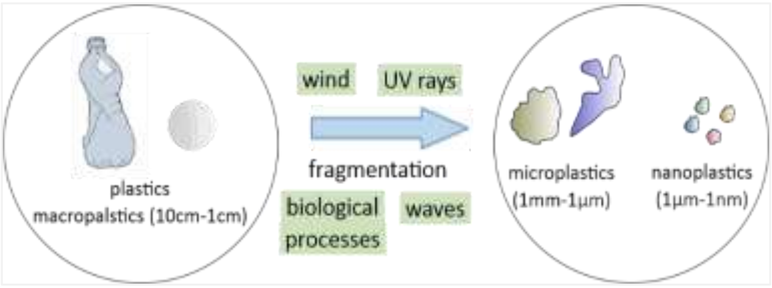


Kata Dorbic is a PhD student in the Department of Chemistry at the University of Fribourg in Switzerland. She has been involved in the study of colloidal systems, primarily in the field of synthesis of differently shaped anisotropic monodisperse particles and their self-assembly.

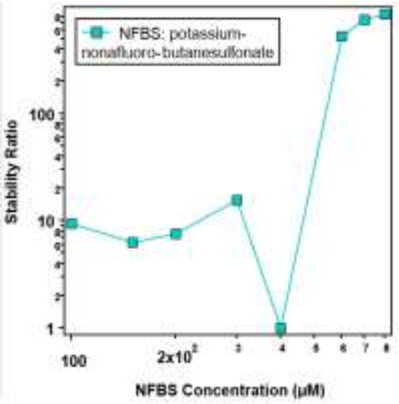
Katalin V. Bere: Modelling the colloidal behavior of nano-sized particles in natural waters

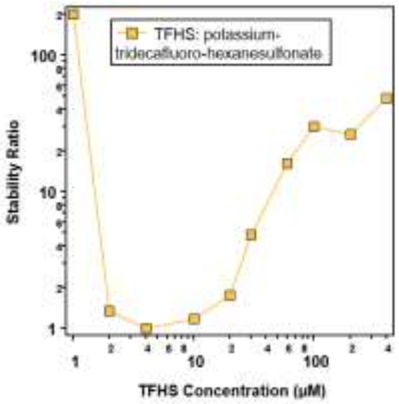
Katalin V. Bere[1], István Szilágyi[1]
1) MTA-SZTE Lendület Biocolloids Research Group, University of Szeged, H-6720 Szeged, Hungary

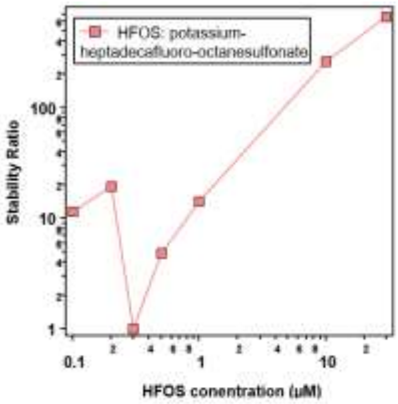
Nowadays the plastic pollution is one of the most important problem which affects the world – for this reason recently they triggered remarkable interests. The biggest emission sources are land-based: in the largest proportion the industry, moreover the consumer society and the marine activity plays sinificant role too. The plastics in the nature are exposed several environmental effects – the mechanical fragmentation, biological degradation and the photochemical oxidation generates the erosion of these materials [1]. These fragmentation effects initializes and eventuates the formations of micro-(5mm-1µm) and nanoplastics (1000 or 100 nm-1 nm). The plastic debrises are reaches the oceans and the seas via riverine transport and here these materials shows their harmful effects [2].



During our project we are working with nano-sized amidine latex particles (ALPs) and potassium salts of perfluoric substances (K-PFXSs, X= name of the carbon atom chain). The colloidal behavior and stability of the ALPs were studied at different ionic strenghts. Thereafter the measurements were directed to the mixing of the positively-charged ALPs and the K-PFXSs. The mixing process induced the charge reversal of the ALPs with the increasing amount of the salts. At charge neutralization, we observed unstable dispersions, while in the positive and the negative regions stable systems were observed. Henceforth we would like to observe the toxicity of these materials. The aim of our research work is to find an operable method for the elimination of these toxicant materials from the natural waters.







References:

[1] L. Wang, W-M. Wu, N. S. Bolan, D. C.W. Tsang, Y. Li, M. Qin, D. Hou, *J. Hazard. Mater.* 401 (2021)

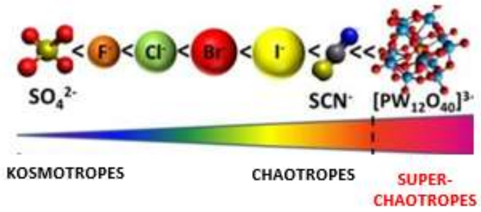
[2] O. S. Alimi, J. F. Budarz. L.M. Hernandez, N. Tufenkji, *Environ. Sci. Technol.* 52 1704-1724 (2018)

Katalin V. Bere (*bere.katalin@chem.u-szeged.hu*) is a PhD student in the Doctoral School of Chemistry of University of Szeged in the Biocolloids Research Group. Her research is concerned with the nanoplastics and elimination of these toxicant materials from the environment. She loves swimming and one of her biggest dream is to reborn as a mermaid. In her next lifetime she would like to live in a clear, nanoplastic-free ocean, so this is one reason why she’s working on this project.

Klaudia Skorzewska: Superchaotropic flotation: an innovative method and a new concept for the extraction and separation of ions by foams.

Klaudia Skorzewska[1], Luc Girard[2], Pierre Bauduin[3]
1) L'Université de Montpellier, ED SCB, Chimie Séparative, Matériaux et Procédés, France
2) Commissariat à l'Energie Atomique, CEA Marcoule, France
3) Laboratory : Ions aux Interfaces Actives, L'Institut de Chimie Séparative de Marcoule, France

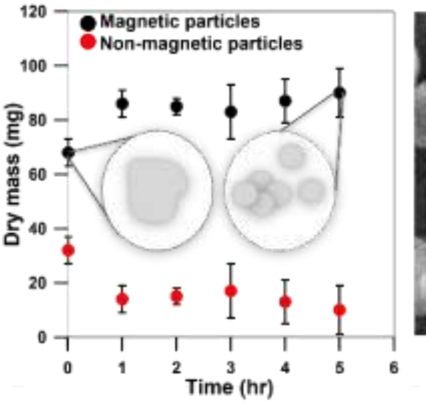
Ion foam flotation (an industrial method) is based on the extraction and separation of ions by foams. The classical ion flotation process make use of ionic foaming agents (surfactants) to extract selectively ions by electrostatics interactions. To transform this process into pure non-electrostatic, superchaotropicity could become a driving force in this system. Superchaotropicity is the general property of low charge density nanometric size ions (nano-ions), which can adsorb strongly onto neutral hydrated surfaces. For example, the large size and low charge density of polyoxometalates (POMs), compared to classical ions, are responsible for this peculiar superchaotropic behavior. The objective of this work was to demonstrate the feasibility of an ion flotation process whose driving force and selectivity would be due to the affinity of superchaotropic nano-ions for uncharged hydrated surfaces, i.e. a non-ionic surfactant foam in a sort of superchaotropic flotation. For this work Molybdenum was chosen for the importance of finding new simple, selective and eco-friendly extraction methods to prevent pollution in the environment in mining industry and because the speciation of molybdate shows in acidic pH the formation of large polyoxospecies such as the Mo36 which has a low charge density and for which we expect a strong superchaotropic property. In this regards, we apply the following chemical system composed of: molybdate polyoxyethylene (10) oleyl ether (BrijO10®) in aqueous solution to investigate the superchaotropic behavior of polyoxomolybdate species. The extraction of Mo with foam was studied as a function of pH and Mo concentration. The adsorption of molybdate species on BrijO10 micelle was studied by SAXS experiment. The speciation of molybdate in the presence of BrijO10 was investigated by Raman spectroscopy.

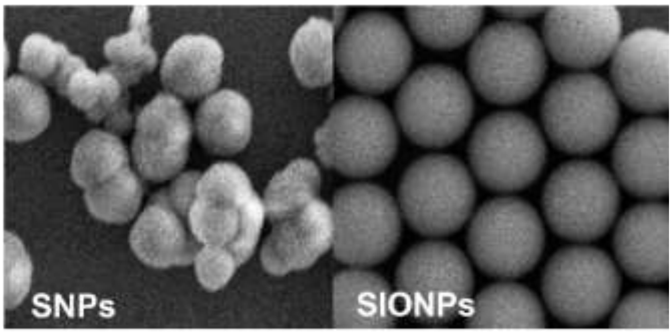


Klaudia Skorzewska (*klaudia.skorzewska@cea.fr*) is a PhD student in the Ecole Doctoral Sciences Chimiques Balard and L'Université de Montpellier. She works and does her PhD researchers in the Comissariat à l'Energie Atomique, in the L'Institut de Chimie Séparative de Marcoule in France. Her thesis project has a connection between two domains: supermolecular chemistry and the science of the separation using concepts of the physical chemistry.

Zeeshan Ali: Influence of Iron Oxide Nanoparticles in Silanization Process

Zeeshan Ali,[1] Jens-Petter Andreassen, [1] Sulalit Bandyopadhyay, [1]
1) Department of Chemical Engineering, Norwegian University of Science and Technology (NTNU), Trondheim, Norway





Controlling synthesis of silica nanoparticles (SNPs) is significant for their applications in various fields such as drug delivery, diagnostics, biosensors, catalysis, etc. since these areas require highly monodisperse and well controlled sizes of SNPs for their efficient performance.[1] Stöber method is one such process that is commonly used for controlled synthesis of monodisperse SNPs in which base catalysed hydrolysis of silica precursor in an alcoholic medium forms silanol monomers and subsequent condensation of the silanol monomers develops a siloxane network that leads further to the formation of SNPs. Depending upon the reaction parameters, the size of SNPs can be varied in the range of 0.05 – 2 µm in diameter, and they can have irregular, aggregates, incompletely fused, or completely spherical morphology.[1] There is substantial gap in literature when it comes to how the different aforementioned morphologies of SNPs are formed from a mechanistic perspective which is further complicated when Stöber method is modified to synthesize silica coated iron oxide nanoparticles (SIONPs) that have been the focus of research in several fields particularly in biomedicine. Combining SNPs with iron oxide nanoparticles (IONPs) makes it easy to separate them magnetically in diagnostic and therapeutic applications, and silica coating offers possibilities to further functionalize their surfaces with biomolecules by exploiting the surface silanol groups.

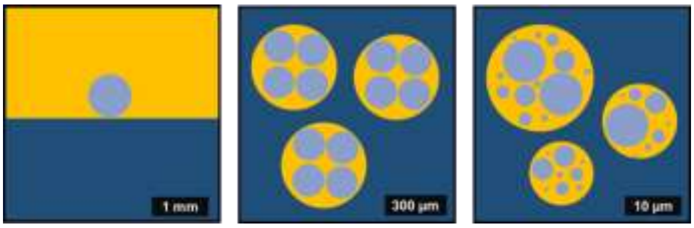
In this study, we present insights into the change in the morphologies and particle sizes of SIONPs during the silanization and mass of magnetic and non-magnetic components of the reaction mixture during silica coating of IONPs. We observed that nature of solvent and concentration of base (ammonium hydroxide) are the most significant factors that control reaction kinetics and morphology of SIONPs and promotes the synthesis of completely spherical/incompletely fused particles. It was also observed that adding IONPs to the Stöber process transforms the morphology of SNPs from incompletely fused particles to spherical SIONPs at specified reaction conditions. We have made a comprehensive attempt to have an understanding of the possible growth mechanisms of SIONPs by studying the change in size and morphology of magnetic and nonmagnetic components of silanization reaction mixture through scanning electron microscopy (SEM) and linking it to change in dry mass of magnetic and non-magnetic components at similar time intervals. Our results show how the addition of IONPs in the silanization process control the resultant particle sizes and morphologies and therefore, will pave the path forward for controlling their growth for enhanced performance in biomedical applications.

References:
[1] A.H. Bari, R.B. Jundale, and A.A. Kulkarni, Understanding the role of solvent properties on reaction kinetics for synthesis of silica nanoparticles. *Chem. Eng. J.* 398 125427 (2020)

Zeeshan Ali (*zeeshan.ali@ntnu.no*) is a PhD candidate at the department of chemical engineering, NTNU. He is studying the synthesis of SIONPs through batch as well as semi-batch process to control their particle size, particle size distribution, morphology and magnetic saturation for various biomedical applications.

Nico Leister: Coalescence phenomena in double emulsions examined via models with different droplet sizes

Nico Leister[1], Heike P. Karbstein[1]
1) Institute of Process Engineering in Life Sciences – Chair of Food Process Engineering, Karlsruhe Institute of Technology, Karlsruhe, Germany



Double emulsions have great potential for encapsulating hydrophilic components in food, cosmetics and pharmaceutics. The active substance is dissolved in a water phase (W_1), and then emulsified in the oil phase (O), which is then protecting the active from the environment. The inner emulsion (W_1/O) again is dispersed in the outer water phase (W_2) for aqueous applications. Due to stability issues, only few products currently exist. During storage, the inner water phase and consequently the active ingredient is lost.

In $W_1/O/W_2$ double emulsions, a lipophilic surfactant stabilizes the encapsulated inner water droplets. A hydrophilic surfactant prevents the coalescence of the oil droplets with each other. To produce double emulsions, the surfactants are added separately to the oil and the outer water phase, respectively. By diffusion, however, the surfactants can distribute over time in all three phases and at both interfaces [1]. This can lead to interactions between the surfactants at the interfaces, which strongly influence the stability of the double emulsion droplets against coalescence.

In this work, the interfaces of double emulsions are investigated in simplified model systems. In these models, the diffusion and interaction of the surfactants is characterized and the resulting stability of the emulsion is determined. The duration until coalescence occurs is measured for millimetre sized single droplets in contact with a planar interface. This is compared to the number of coalescence events in monodisperse emulsions produced by microfluidics. Finally, the changes in droplet size distribution of mechanically emulsified emulsions are used to prove the transferability between the size scales [2]. Comparing the resulting stability of different surfactant groups, general suggestions on hydrophilic-lipophilic surfactant pairings for the production of double emulsion systems can be given.

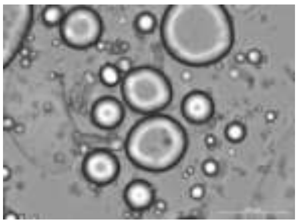
References:

[1] Leister, N. and Karbstein, H.P. Evaluating the Stability of Double Emulsions–A Review of the Measurement Techniques for the Systematic Investigation of Instability Mechanisms. *Colloids and Interfaces*, 4 (1) 8 (2020)
[2] Leister, N., Yan, C., Karbstein, H.P. 2022 Oil Droplet Coalescence in W/O/W Double Emulsions Examined in Models from Micrometer- to Millimeter-Sized Droplets. *Colloids and Interfaces*, 6 (1) 12 (2022)

Nico Leister (*nico.leister@kit.edu*) is working as a PhD student in the research group of Prof. Dr.-Ing. Heike Karbstein since 2017 at the Karlsruhe Institute of Technology on the stability of double emulsion formulations in a project from AiF (Pre-competitive Industrial Collective Research). In cooperation with BASF SE, Loughborough University and the University of Applied Sciences in Mannheim, different approaches to characterize the stability of interfaces with two or more surfactants present were developed and used to optimize double emulsion formulations for food, cosmetics and pharmaceutics.

Eleni Galani: Preparation and Characterization of emulsions stabilized by Pea and Soy Protein Isolates for the encapsulation of a- tocopherol and squalene.

Eleni Galani[1,2], Constantina Chalkiopoulou[1], Theodora Katsilla[1], Maria D. Chatzidaki[1], Aristotelis Xenakis[1]
[1]Institute of Chemical Biology, National Hellenic Research Foundation
[2]Food Chemistry & Human Nutrition, School of Food, Biotechnology and Development, Agricultural University of Athens



Nowadays there is a turn towards the replacement of animal proteins by ones deriving from plants in an effort to reduce the consumption of animal products [1]. This change in direction has also affected the food industry where proteins are used as emulsion's stabilizers and research is now more oriented towards plant-based products[2]. The aim of this project was to formulate and study plant-based emulsions that are stabilized by Pea Protein Isolate (PPI) and Soy Protein Isolate (SPI) for the encapsulation of a-tocopherol and squalene. For this purpose, PPI and SPI particles were formed by the pH modification method. The emulsions were prepared using high speed-homogenization and were observed both macroscopically and microscopically. The emulsions' droplet size as well as their antioxidant capacity were determined. It was found that the mean droplet diameter of the SPI emulsions was 33.6 μm, while of the PPI emulsions 31.9 μm. Both the empty and the loaded emulsions showed scavenging activity of the DPPH radical, with the ones loaded with vitamin E having the greatest antioxidant capacity. Furthermore, with the use of the Bicinchoninic acid (BCA) protein assay it was estimated that about 70% of the PPI is adsorbed on the interface of the emulsions' droplets while the adsorption of the SPI was estimated to 45%. In terms of stability SPI emulsions were not stable for more than 4 days at room temperature. PPI emulsions remained stable for at least 15 days.

References:

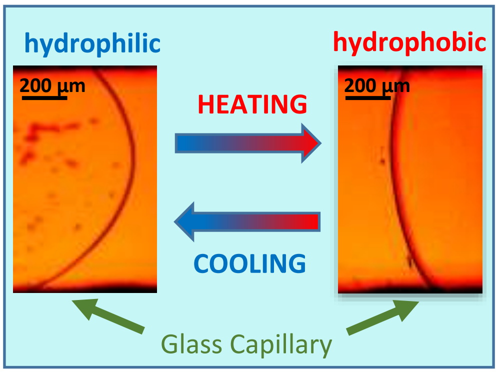
[1] S. T. Itkonen et al., "Partial Replacement of Animal Proteins with Plant Proteins for 12 Weeks Accelerates Bone Turnover Among Healthy Adults: A Randomized Clinical Trial," *J Nutr*, 151(1) 11–19 (2021)

[2] C. Amine, J. Dreher, T. Helgason, and T. Tadros, "Investigation of emulsifying properties and emulsion stability of plant and milk proteins using interfacial tension and interfacial elasticity," *Food Hydrocolloids*, 39 180–186 (2014)

Eleni Galani (*egalani@eie.gr*) is a co-supervised PhD student in the Agricultural University of Athens and the Institute of Chemical Biology at the National Hellenic Research Foundation. She has been involved in industry-academic collaborations and her main research interest is the production of functional plant-based foods.

Lee Shool: Apparent Young-violating concave-convex switching of curved oil-water menisci

Lee Shool[1], Alexander V. Butenko[1], Eli Sloutskin[1]
1) Physics Deptarment and Institute of Nanotechnology & Advanced Materials, Bar-Ilan University, Ramat-Gan 5290002, Israel



Controlling the curvature of the meniscus is crucial in a wide range of technologies, ranging from interfacial assembly methods, to liquid lens technologies, microfluidics, direct-write 3D printing of functional materials, thermal management and printing of microelectronic devices, and more. The physics of meniscii and their shapes is also fundamental for many natural phenomena. However, while the existing methods allow the curvature to be controlled only by varying the chemical composition of the sample, by surface treatment, or by external fields, reversible convex-concave curvature switching of menisci by simply varying the temperature has never been hitherto reported.

I will demonstrate, that such temperature-controlled curvature inversion is possible for a capillary-contained macroscopic water:oil interface. This phenomenon occurs under the joint, interrelated, action of two nanoscale effects: one is the interfacial freezing, whereby a crystalline monolayer spontaneously forms at the interface between two liquid bulk phases, at a temperature T_S. The freezing switches the temperature-slope of the oil:water interfacial tension γ_{ow} from slightly negative at $T > T_S$, to strongly positive at $T < Ts$, causing γ_{ow} to decrease upon cooling, and vanish at some T_{SE}, above the bulk freezing point of the oil. The second effect is a unique hydrophilic-hydrophobic transition of the liquid-containing glass capillary's walls. While thermal hydrophobicity-hydrophilicity transformations have been observed under nano confinement conditions, no such transformations have been hitherto reported for bulk materials contained in macroscopic capillaries. Such transformations may allow the direction of capillary action to be reversed, significantly influencing wicking, imbibition, wetting, narrow channel or soil penetration, as well as other nanotechnology-related phenomena. Remarkably, I will demonstrate that the shape of the meniscus strongly depends on the width of the containing capillaries, in an apparent violation of Young's equation. We elucidated the mechanism of this dependence by a combination of systematic optical microscopy measurements and computer simulations.

References:

[1] Lee Shool, Alexander V. Butenko, Shir R. Liber, Yitzhak Rabin, and Eli Sloutskin
The Journal of Physical Chemistry Letters 12(29) 6834-6839 (2021)

Lee Shool (*lee.school789@gmail.com*) is a PhD student in the Institute of Nanotechnology & Advanced Materials, physics department, Bar-Ilan University, Israel. Her current work is about Shape transformations in surfactant/particle co-stabilized emulsions, undergoing surface freezing. Formerly she studied planar oil-water menisci.

Angelo Musicò: Protein Corona and EV surface engineering

Angelo Musicò[1,2], Rossella Zenatelli[1,2], Miriam Romano[1,2], Andrea Zendrini[2], Marina Cretich[3], Chiara Urbinati[1], Marco Rusnati[1], Giuseppe Pomarico[1,2], Paolo Bergese[1,2], Annalisa Radeghieri[1,2]
1) Department of Molecular and Translational Medicine, University of Brescia, 25123 Brescia, Italy
2) CSGI, Research Center for Colloids and Nanoscience, 50019 Florence, Italy
3) National Research Council of Italy-Istituto di Scienze e Tecnologie Chimiche (SCITEC-CNR), Milan, Italy.

Extracellular vesicles (EVs) are cell-derived membranous soft nanoparticles with outstanding medical translational opportunities[1]. For several of these applications, post-isolation (exogenous) engineering of the EV surface is needed (e.g., to increase EV tropism). One strategy for EV exogenous engineering can be performed by covalently bonding organic molecules, like small peptides or whole proteins, to improve their targeting and pharmacokinetics[2]. However, EVs can adsorb proteins at the interface between their membrane and the extravesicular space. This phenomenon is shared with all the nanoparticles immersed in biological fluids and leads to the formation of a so-called Protein Corona (PC). In EVs, the PC can reach up to 50% of the proteins associated with the EV membrane[3]. The effects of PC on EVs have started to be investigated[3] but its role during EV engineering processes has been underrated, although it is evident that it may dramatically influence it, at every stage. As a core part of my PhD project, we aim at evaluating this aspect.

We used two EV models: Red Blood Cells derived EVs and EVs isolated from Hek293T cells. EVs were engineered with Cetuximab (CTX), a chimeric monoclonal antibody that targets the epithelial growth factor receptor (EGFR), by biorthogonal Strain Promoted Azido-Alkyne Cycloaddition (SPAAC) click-chemistry reaction. We prepared EV samples with and without the azido group needed to react with the DBCO previously bound to the CTX and we found that CTX co-isolate with EVs even in the absence of the azido group required for the click-chemistry reaction. Thus, we suggested a Protein Corona-like phenomenon, where the antibody is non-specifically adsorbed onto the EV surface. Measurements of the repartition coefficient of the CTX between EV surface and the media in different EV populations showed an inverted proportionality between the EV diameter and repartition coefficient. In the contribution, we will introduce this original addition to EV engineering subject and present our latest results, including an evaluation of different molecular recognition abilities between antibodies bounded specifically and adsorbed unspecifically.

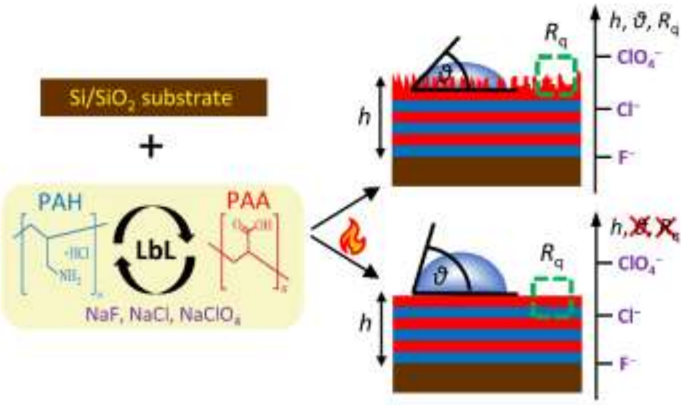
References:
[1] Busatto, S. *et al.* The nanostructured secretome. *Biomaterials Science* vol. 8 39–63 (2020).
[2] Richter, M., Vader, P. & Fuhrmann, G. Approaches to surface engineering of extracellular vesicles. *Advanced Drug Delivery Reviews* 173 416–426 (2021)
[3] Tóth, E. *et al.* Formation of a protein corona on the surface of extracellular vesicles in blood plasma. *Journal of Extracellular Vesicles* 10 (2021)

Angelo Musicò (*a.musico@unibs.it*) is a co-supervised first-year PhD student in the Doctoral School of Precision Medicine at the University of Brescia. He has been involved in projects regarding the chemical engineering of extracellular nanoparticles for enhanced tracking and targeting.

He is also involved in a personal project which aims to discover the recipe for making the best IPA in the world

Tin Klačić: Supporting Anion and Heating Effect on Properties of Dry Layer-by-layer Assemblies Containing Poly(allylamine hydrochloride) and Poly(acrylic acid)

Tin Klačić,[1] Klemen Bohinc,[2] Davor Kovačević[1]
1) Division of Physical Chemistry, Department of Chemistry, Faculty of Science, University of Zagreb, Horvatovac 102a, Zagreb, Croatia
2) Faculty of Health Sciences, University of Ljubljana, Zdravstvena pot 5, Ljubljana, Slovenia



Polyelectrolytes are macromolecules (*e.g.* polymers) with dissociating functional groups which can carry positive or negative charge in solution. By alternating adsorption of positively and negatively charged polyelectrolytes on a charged surface, polyelectrolyte multilayers are formed. These nanocomposites have interesting properties and are applied in various scientific fields, mainly in biomedicine and pharmacology [1, 2].

In this study, ultrathin films have been fabricated on silicon wafers from layer-by-layer assembled poly(allylamine hydrochloride), PAH and poly(acrylic acid), PAA. Contact angle measurements, atomic force microscopy and ellipsometry were used to investigate the influence of the supporting sodium salt on the build-up and properties of PAH/PAA multilayer. It was found that the properties of prepared PAH/PAA multilayers follow the Hofmeister series. Thus, hydrophobicity, surface roughness, and film thickness increase in the order $F^- < Cl^- < ClO_4^-$. Interestingly, this ion-specific effect was suppressed when films were exposed to slight heating after each adsorption cycle. In this case, the choice of background salt didn't affect wettability and surface roughness of PAH/PAA multilayer, but it affected the thickness of the film.

Acknowledgements: This research was supported by the Croatian Science Foundation under the bilateral Slovenian-Croatian APPLPEMS project (IPS-2020-01-6126).

References:
[1] S. Zhao *et al.*, *ACS Nano* 13 6151–6169 (2019)
[2] K. Bohinc, L. Kukić, R. Štukelj, A. Zore, A. Abram, T. Klačić, D. Kovačević, *Coatings* 11 630 (2021)

Tin Klačić (*tklacic@chem.pmf.hr*) is a PhD student employed as an assistant at the Department of Chemistry, Faculty of Science in Zagreb. His teaching activities at the Division of Physical Chemistry where he works are connected to seminars and laboratory exercises in the several physical chemistry courses for undergraduate and graduate students. The main areas of his scientific work are colloidal and interfacial chemistry, physical chemistry of macromolecules (especially polyelectrolytes), electrochemistry, and chemical kinetics. In his free time, he likes to read books that relax him. One of his favorites books is *Atkins' Physical Chemistry*. ☺

Marta Kalbarczyk: Biphasic calcium phosphate (BCP) material originated from avian eggshells: the synthesis and adsorption studies

Marta Kalbarczyk[1]*, Aleksandra Szcześ*[1]*, Zoltan May*[2]*,*
1) Department of Interfacial Phenomena, Institute of Chemical Sciences, Faculty of Chemistry, Maria Curie-Skłodowska University in Lublin, Poland
2) Institute of Materials and Environmental Chemistry Research Center for Natural Science, Budapest, Hungary

In order to reduce the production costs and for the environmental benefits the usage of wastes as a precursor in chemical synthesis is prevalent. In last 30 years scientists effectively applied different materials with unconventional origin such as fish bones, seashells, eggshells, mammalian bones, shrimp shells, or snail shells as a source of calcium during biomaterials synthesis [1].

A biocompatible, biodegradable and bioavailable hydroxyapatite (HA) was proved to be an excellent compound not only for medical applications (in orthopaedic and dental replacements or drug carrier) but also as the adsorbent in waste water purification [2]. The wide range of investigations on the biphasic calcium phosphates (BCP), among others, the mixture of HA and β-tricalcium phosphate (β-TCP) phases at a different ratios, considered BCP to be more efficient compare with pure one- phase materials [3].

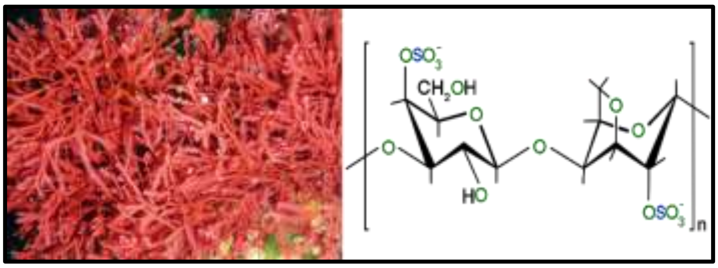
The aim of the presented investigation is the synthesis of a biphasic calcium phosphate material (BCP) from pigeon, quail, hen and duck eggshells. The procedure was applied for the eggshells with and without the inner eggshell membrane (ESM). The composition and morphology of the obtained products were determined using the SEM, XRD and FTIR analyses and it was proved that the most beneficial structure was obtained for the material originated from hen eggshells with ESM. The chosen material was then analysed to examine its ability to purify aqueous solutions from heavy metal ions (such as Ni(II), Cd(II), Cu(II) and Pb(II)). The static sorption method in the pH range from 3 to 7 was applied and mechanism of the process with respect to the Langmuir and Freundlich adsorption models was studied.

References:
[1] S.-L. Bee, Z. A. A. Hamid, *Ceram. Int.l*, 46 17149 (2020)
[2] S. Pai, S. M Kini, R. Selvaraj, A. Pugazhendhi, *J. Water Process Eng.* 38 101574 (2020)
[3] S. Basu, B. Basu, *ACS Appl. Bio Mater.* 2 5263 (2020)

Marta Kalbarczyk (*marta.kalbarczyk@umcs.pl*), is currently a PhD student of International PhD Studies in Chemistry at Maria Curie- Skłodowska Univesrity in Lublin, Poland. Her scientific interests are focused on synthesis and properties of calcium phosphate materials originated from waste sources. She spent 6 months in Budapest in the Institute of Materials and Environmental Chemistry Research Center for Natural Science where she studied adsorption processes of heavy metal ions.

Samantha K. Samaniego Andrade: Effect of GO doping on marine biomass based porous carbon and implications for oxygen reduction reaction

Samantha K. Samaniego Andrade[1], István Bakos[2], Attila Farkas[3], Miklós Mohai[2], Krisztina László[1]
1) Department of Physical Chemistry and Materials Science, Budapest University of Technology and Economics, 1521 Budapest, Hungary
2) Institute of Materials and Environmental Chemistry, Research Centre for Natural Sciences, Eötvös Loránd Research Network, Magyar tudósok körútja 2., Budapest, H-1117, Hungary
3) Department of Organic Chemistry and Technology, Budapest University of Technology and Economics, 1521 Budapest, Hungary



Due to their chemical composition and high availability, biomass has been a raw material for producing porous carbons for decades. These carbons have been prof effective in applications such as energy conversion, gas storage/separation, water treatment, etc. Marine biomass represents a great portion of the global biomass and its potential as carbon source has not been explored fully [1]. In our study, we chose i-carrageenan which is a red seaweed derived compound suitable for porous carbon production. The intrinsic S content in i-carrageenan as well as its inorganic salt content (K, Ca, Na) benefits the structure of the final carbon; urea is added as N source to obtain a dual doped N,S porous carbon. During synthesis part of S becomes built into the carbon framework while the heteroatoms work as template and enhance the porosity after removing them by acid washing. The result is a highly porous metal free double doped carbon material (CA) with similar performance in oxygen reduction reaction as a 20 wt % Pt/C commercial electrode [2].

To improve the electrocatalytic properties of the CA material various amounts of graphene oxide are added early in the synthesis. The goal is to increase the thermal/electric conductivity of the carbon and promote the formation of defects in its framework. It is expected the reduced GO forming during the heat treatment improves the electrocatalytic performance of the carbon. The effect of GO on the texture and chemistry of the final carbon is studied using scanning electron microscopy (SEM), low temperature N_2 adsorption/desorption, CO_2 adsorption/desorption, Raman spectroscopy, and X-ray photoelectron spectroscopy (XPS). The electrocatalytic performance is tested in a three-electrode cell in 0.1 M electrolyte which is typical of an alkaline anion-exchange membrane fuel cell (AAEMFC).

References:
[1] Gambles, R. *et al*. In *Research in thermochemical biomass conversion*, 1st ed.; Bridgwater, A. V., Kuester, J. L., Eds.; Springer Netherlands: Heidelberg, Germany, 1988.
[2] Samantha K. Samaniego Andrade *et al*. Materials, 14 3488 (2021)

Samantha K. Samaniego Andrade (*ssamaniegoandrade@edu.bme.hu*) is a PhD student in the Department of Physical Chemistry and Materials Science at the Budapest University of Technology and Economics. She works under the supervision of Professor Krisztina László, head of the Surface Chemistry Group. Samantha's research is focused on developing highly porous carbon materials suitable for energy conversion and gas separation-storage. She comes from Zaruma-Ecuador and she is a grantee of the Stipendium Hungaricum scholarship program. In her free time Samantha enjoys going hiking, dancing, and watching movies.

Eszter Kása: Modified sodalite with O-type additives for efficient removal of basic fuchsine dye from aqueous solutions

Eszter Kása[1], Ivett Petri[2], Márton Szabados[1], Bence Kutus[2], Pál Sipos[2]
1) Department of Organic Chemistry, University of Szeged, Szeged, Hungary
2) Department of Inorganic and Analytical Chemistry, University of Szeged, Szeged, Hungary

Bayer process is the principal technique in the alumina industry to obtain pure aluminium hydroxide from bauxite ore; however, it also produces more than 2.7 billion tons of red mud/bauxite residue worldwide. This by-product is an alkaline solid waste generated by extraction of alumina from bauxite in refineries. Currently, almost all bauxite residue is stored indefinitely in land-based red mud disposal areas [1]. Therefore, the decrease of this quantity is crucial in the alumina industry. On the other hand, synthetic dyes are considered as major water resource contaminants in many industrial fields (textile, paint, leather, etc). These organic dyes are highly carcinogen and thus hazardous, their bioaccumulation in aquatic bodies causes enormous environmental problems [2]. This work connects the two environmental problems by using modified sodalite as an easily available and cheap adsorbent for removal of basic fuchsine – a representative textile dye from aqueous solutions. The adsorption was followed *via* spectrophotometer.

Sodalite (SOD) is one of the main components of the bauxite residue. However, it is a microporous aluminosilicate with a low pore size and surface area, the adsorption capacity of this solid can be increased by several techniques. In this work, modified sodalites were synthesized mimicking the Bayer process and started from pretreated kaolinites. Next to mechanochemical activation and heat treatment [3], O-type additives can also improve the textural parameters of SOD; thus, they were able to become more effective adsorbents. The SOD particles were characterized by XRD, IR, N_2 adsorption technique and SEM, and their adsorption performance was compared to those of activated carbon and zeolites.

References:

[1] I.T. Burke, C.L. Peacock, C.L. Lockwood, D.I. Stewart, R.J.G. Mortimer, M.B. Ward, P. Renforth, K. Gruiz, W.M. Mayes, *Environ. Sci. Technol.* 47 6527-6535 (2013)

[2] B. Ba Mohammed, A. Hsini, Y. Abdellaoui, H.A. Oualid, M. Laabd, M. El Ouardi, A. Ait Addi, K. Yamni, N. Tijani, *J. Environ. Chem. Eng.* 8 104419-104429 (2020)

[3] E. Kása, M. Szabados, K. Baán, Z. Kónya, Á. Kukovecz, B. Kutus, I. Pálinkó, P. Sipos, *Appl. Clay Sci*. 203 105994-106004 (2021)

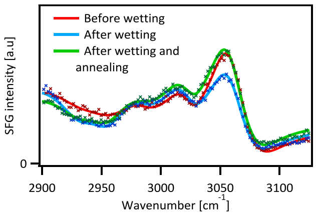
Eszter Kása (*eszterorban94@chem.u-szeged.hu*) is a PhD student in the Chemical Doctoral School of University of Szeged and member of the Material and Solution Structure (MASOST) Research Group. She has been part of industrial projects during her studies under the supervision of Prof. Dr. Pál Sipos, focusing on the reduction and/or remediation of the bauxite residue. In her spare time, Eszter likes to travel and meet new people and discover different cultures.

Mirela Evgenieva Encheva: Water Induced Polymer Reorientation at a Polystyrene/Polyacrylic Acid Surface

Mirela Evgenieva Encheva[1,2], Xiaomei Li[3], Hans-Jürgen Butt[3], Rüdiger Berger[3], Ellen H. G. Backus[1,2]
1) University of Vienna, Faculty of Chemistry, Institute of physical chemistry, Währinger Straße 42, 1090 Vienna, Austria.
2) University of Vienna, Vienna Doctoral School in Chemistry (DoSChem), Währinger Str. 42, 1090 Vienna, Austria
3) Max Planck institute for polymer research, Ackermannweg 10, 55128 Mainz, Germany.

Polymers are capable of adapting to a wide range of stimuli such as pH, temperature or light [1,2,3]. One such stimulus is direct contact with liquids, as certain types of polymers, like block copolymers, base their segment orientation on the polarity of the liquid they interact with [4].

In this work, we focus on the adaptation of polystyrene/polyacrylic acid (PS/PAA) copolymer thin films after wetting. Previous research showed that the contact angle of the copolymer before exposure to water was higher than the value obtained after wetting [5]. This difference in the contact angles may be caused by swelling of the copolymer or by a reorientation of the hydrophilic segments (PAA) towards the surface. Our objective is to determine whether a restructuring of the film occurs after wetting.



To achieve this goal, we use sum-frequency generation (SFG) spectroscopy. This technique allows us to obtain vibrational spectra of interfaces, thus becoming an ideal tool to identify molecular changes on the surface of the copolymer. In our experiments, we compared the spectra of the PS/PAA films before and after contact with water. The results revealed a decrease in the intensity of the band at roughly 3050 cm^{-1} representing the PS vibrations, suggesting a depletion of the hydrophobic segments of the surface. This demonstrates that the reorientation of the film contributes to the previously observed decrease in contact angle. In addition, we also studied the reversibility of the restructuring by annealing the sample after water exposure. Our results reveal that the band PS assigned band recovers its intensity after annealing, proving the reversibility of the process [6].

References:
[1] G. Kocak, C. Tuncer, and V. Bütün, *Polymer Chemistry*, 8, 114-176 (2017).
[2] T. Nonoyama, Y. W. Lee, K. Ota, K. Fujioka, W. Hong and J. P. Gong, *Advanced Materials*, 32, 1905878 (2019).
[3] Y. Gu, E. A. Alt, H. Wenig, X. Li, A. P. Willard and J. A. Johnson, *Nature*, 560, 65-69 (2018).
[4] H. J. Butt, R. Berger, W. Steffen, D. Vollmer and S. A. L. Weber, *Langmuir*, 34, 11292-11304 (2018)
[5] X. Li, S. Silge, A. Saal, G. Kircher, K. Koynov and R. Berger, *Langmuir*, 37, 1571-1577 (2021).
[6] X. Li, M. Encheva, H.-J. Butt, R. Berger, E. H. G. Backus, *Macromolecular Rapid Communications*, submitted 2022.

Mirela Encheva (*mirela.encheva@univie.ac.at*) is a PhD student in the Institute of physical chemistry in the University of Vienna. Although she graduated in biotechnology (2019), she decided to focus her future research on physical-chemistry fields. At the end of her master's degree in Nanotechnology (2020) she started a PhD related to spectroscopy in the group of Ellen Backus. In her free time, she likes shooting lasers all around the lab rooms.

Matteo Frigerio: Phosphate ion triggered modifications of oil/water interfaces

Matteo Frigerio[1], Stefan Salentinig[1]
1) Department of Chemistry, University of Fribourg, Chemin Du Musée 9, 1700 Fribourg, Switzerland

Oil/water interfaces are regions of excess free energy ubiquitous in colloids. The energy required for emulsification of oil in water is proportional to the interfacial tension. Certain ions were found to reduce the surface tension in a surfactant-free way[1]. This can help to reduce the consumption of surfactants while ensuring the decrease in surface tension and costs associated to the emulsification process from a practical point of view. However, the role of ions and the enhancement in interfacial features is still matter of debate as there are many factors, such as the polarizability[2] that come into play. Here we show that phosphate buffer, a commonly used buffer system in many studies, can significantly alter the lipid-water under certain pH conditions. Spinning drop tensiometry demonstrated the pH-triggered reduction of the interfacial tension between oil and water in presence of phosphate buffer. Monohydrogen phosphate (MHP) even appeared to crystallise at the water-triolein interface (Figure 1), in contrast to a plethora of other ions that were studied. Ellipsometry and Brewster angle microscopy showed the MHP triggered formation of layers at the interface, with a refractive index that is comparable to supersaturation conditions of the MHP. Moreover, stabilizer-free GMO cubosomes are used as a platform to analyse the integrations of the ions into lipid-water interfaces. Small angle X-ray scattering showed their structural transformation from double diamond Pn3m-type cubic phase in water[3] to primitive Im3m-type upon addition of MHP. Complementary techniques such as molecular dynamics and interfacial tension measurements all point in the same direction. Our results pave the way for a more systematic study on the interfacial role of ions in processes of biological relevance[4] such as calcium removal of long chain fatty acids from oil/water interface in lipid digestion.

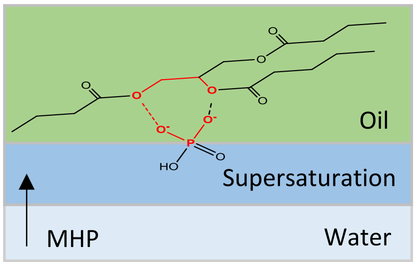


Figure 4. Sketch diagram for supersaturation conditions established upon MHP adsorption at the interface and following crystallization

References:
[1] Badizad, Mohammad Hasan, et al. "How do ions contribute to brine-hydrophobic hydrocarbon Interfaces? An in silico study." *Journal of Colloid and Interface Science* 575 337-346 (2020)
[2] Chang, Tsun-Mei, and Liem X. Dang. "Recent advances in molecular simulations of ion solvation at liquid interfaces." *Chemical Reviews* 106(4) 1305-1322 (2006)
[3] Zabara, Mahsa, et al. "Multifunctional nano-biointerfaces: cytocompatible antimicrobial nanocarriers from stabilizer-Free cubosomes." *Advanced Functional Materials* 29(35) 1904007 (2019)
[4] Salentinig, Stefan, et al. "Transitions in the internal structure of lipid droplets during fat digestion." *Soft Matter* 7(2) 650-661 (2011)

Matteo Frigerio (*matteo.frigerio@unifr.ch*) is a second year PhD student in the Biocolloids group at the Department of Chemistry of University of Fribourg. His research focuses on elucidating the mechanism behind interfacial organization phenomena in the area of lipid chemistry and food digestion by means of ellipsometry, scattering techniques and computational methods.

Adrianna Biedrzycka: Physicochemical properties of hydroxyapatite/iron oxide composite surface - zeta potential measurements

Adrianna Biedrzycka,[1] Ewa Skwarek[1]
1) Department of Radiochemistry and Colloidal Chemistry, Faculty of Chemistry, Maria Curie-Sklodowska University in Lublin, Poland

Hydroxyapatite is a well-known mineral consisting mainly of calcium and phosphorus ions with a molar Ca/P ratio of 1.67. It is a component of bones and teeth, but also occurs in nature in the form of rocks. It owes its popularity to the properties it exhibits, including good sorption capacity, thermal stability and biocompatibility with human tissues. Recently, there has been a noticeable increase in interest in the study of hydroxyapatite, especially its modifications [1, 2].

An interesting modification of hydroxyapatite is the use of iron oxide as a core. The most popular oxides used for this purpose are Fe_3O_4 and Fe_2O_3, which exhibit magnetic properties and give the resulting composite a multifunctional character [3].

One of the most valuable parameters that could be measured is zeta potential. It gives information about the potential occurring at the surface of a solid or other dispersed particle. The existence of this potential is the cause of electrokinetic phenomena. This parameter is used to determine the stability of colloidal systems. This property is quite important because composite derived from hydroxyapatite and iron oxide is a promising material in cation adsorption processes. Thus, the experiments were conducted in the following systems: hydroxyapatite/ Ag, iron oxide/ Ag, composite/ Ag as well as hydroxyapatite/ U, iron oxide/ U and composite/ U. Moreover, zeta potential was also measured in samples without any additional presence of metal ions. The results were interesting.

The zeta potential of the samples was tested in the pH range of 3 to 11, and the zeta potential values were from 30 mV to -35 mV. The trend of the samples was difficult to predict. The results depended on the type of ion present and its concentration.

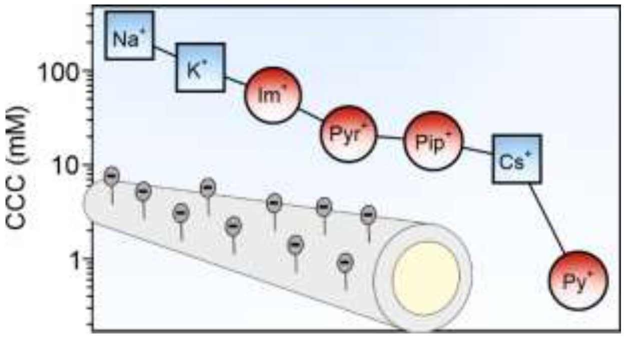
To sum up, zeta potential is a significant property of solids. Obtained results are promising. However, there is still a need to improve and diversify studies concerning the composite hydroxyapatite/ iron oxide.

References:
[1] A. Biedrzycka, E. Skwarek, M.H.Urban, Hydroxyapatite with magnetic core: Synthesis methods, properties, adsorption and medical applications, *Advances in Colloid and Interface Science* 291, 102401 (2021).
[2] M. Ibrahim, M. Labak, J.M. Giraudon, J.F. Lamonier, Hydroxyapatite, a multifunctional material for air, water and soil pollution control: A review, *Journal of hazardous materials* 383, 121139 (2020).
[3] E. Tombácz, R. Turcu, V. Socoliuc, L. Vékás, Magnetic iron oxide nanoparticles: Recent trends in design and synthesis of magnetoresponsive nanosystem, *Biochemical and biophysical research communications* 468, 442-453 (2015).
[4] A. Biedrzycka, E. Skwarek, D. Osypiuk, B. Cristóvao, Synthesis of Hydroxyapatite/Iron Oxide Composite and Comparison of Selected Structural, Surface, and Electrochemical Properties, *Materials*, 15(3) 1139 (2022).

Adrianna Biedrzycka (a.biedrzycka@poczta.umcs.lublin.pl) is a PhD student of the second year in the Doctoral School of Quantitavite and Natural Sciences in the discipline of chemical sciences. Doctoral thesis is carried out in cooperation with Prof. Ewa Skwarek in Department of Radiochemistry and Environmental Chemistry, Institute of Chemical Sciences, Maria Curie-Skłodowska University in Lublin. She actively participates in numerous national and international conferences. She is also the author of scientific articles in respected journals. The chosen research topic, i.e. the synthesis of hydroxyapatite composite with magnetic core and the analysis of selected properties, indirectly responds to current environmental problems and fills the gaps in the current state of knowledge.

Bojana Katana: Halloysite Nanotube Colloids – Ion Specific Effects and Enzyme Immobilization

Bojana Katana[1]*, Dóra Takács*[1]*, Istvan Szilagyi*[1]
1) MTA-SZTE Lendület Biocolloids Research Group, Department of Physical Chemistry & Materials Science, University of Szeged, 6720-Szeged, Hungary



Halloysite nanotubes (HNTs) are layered aluminosilicates ($Al_2Si_2O_5(OH)_4{\cdot}nH_2O$) with hollow tubular structure and two different surface charge states. HNTs represent an interesting class of materials due to their advantageous properties such as biocompatibility, abundance of surface functional groups, and large-scale availability. HNTs are promising candidates as solid supports in the immobilization processes of biomolecules [1]. Nevertheless, surface functionalization of HNTs with macromolecules is necessary to strengthen the adsorption of the quest molecules and to avoid unwanted aggregation processes. Our study focused on the development of stable colloids from a nanocomposite consisting of self-assembled biomacromolecules such as a protamine sulfate polyelectrolyte (PSP) and superoxide dismutase (SOD) enzyme on HNT surfaces. Prior to the preparation of such nanocomposites, the effect of monovalent electrolytes and some water-soluble ionic liquids, on the surface charge and aggregation of HNT particles was investigated using electrophoretic and dynamic light scattering techniques. The Hofmeister series for cations was established and extended with ionic liquids by using the measured critical coagulation concentration (CCC) values (TOC figure) [2]. The same measurements were performed with polyimidazolium-functionalized halloysite nanotubes (HNT-IP-2), and the results pointed out that no such tendencies in the CCCs are present for the HNT-IP-2 particles. This surprising behaviour sheds light on the fact that the surface functionalization with the polyimidazolium compound effectively masks the interfacial ion specific effects. In addition, a nanocomposite consisting of HNT with self-assembled PSP and SOD biomacromolecules on the outer surface was developed and considered as a highly active antioxidant.

References:

[1] Katana, B.; Rouster, P.; Varga, G.; Muráth, S.; Glinel, K.; Jonas, A. M., and Szilagyi, I., Self-assembly of protamine biomacromolecule on halloysite nanotubes for immobilization of superoxide dismutase enzyme, *ACS Appl. Bio Mater.* 3 522-530 (2020)
[2] Katana, B.; Takács, D.; Csapó, E.; Szabó, T.; Jamnik, A., and Szilagyi, I., Ion specific effects on the stability of halloysite nanotube colloids-inorganic salts versus ionic liquids, *J.Phys.Chem. B,* 124 9757-9765 (2020)

Bojana Katana (*bkatana@chem.u-szeged.hu*) is a 4th-year Ph.D. student at MTA-SZTE "Lendület" Biocolloids Research Group at the Department of Physical Chemistry at the University of Szeged. Her work is related to the project "Development of nanocomposite dispersions with antioxidant effect". Her research is concerned with the development of nanocomposites with biocatalytic activity and their formulation in aqueous and ionic liquid medium. She is familiar with the surface modification and colloidal chemical characterization of halloysite nanotubes and has also studied the interaction between ionic liquid constituents and halloysite nanotubes.

Dóra Takács: Effect of ionic liquid constituents on the stability of layered double hydroxide dispersions

Dóra Takács,[1] Bojana Katana,[1] István Szilágyi[1]
1) MTA-SZTE Momentum Biocolloids Research Group, University of Szeged, H-6720, Szeged, Hungary

Layered double hydroxides (LDHs) represent a class of inorganic layered materials, therefore their application is often based on anion exchange or intercalation of specific guest molecules. However, the strong attraction between the highly charged hydroxide layers and the interlayer anions hinders the access to the interlayer space in many cases. From this aspect ionic liquids (ILs), as solvents, are of particular interest, since they are able to reduce the strength of attractive forces between charged surfaces due to the possible combined effect of their interfacial assembly or partial dissociation [1]. Nevertheless, once these nanoparticle dispersions are involved in the application processes, the colloidal stability in ILs or in their water mixtures is a key point.

For that reason, the surface charge features and aggregation kinetics of LDH particles were assessed by light scattering techniques to probe the effect of the IL constituents, since the interfacial assembly of IL constituents should play a crucial role in the stability of particles in ionic media [2]. The deviation between the zeta potential and stability ratio data by varying the IL composition indicated specific ion adsorption on the particle surface. This observation shed light on the fact that IL ions interact strongly and specifically with the particle surface. Although the origin of the interparticle forces was very similar in all systems regardless of the ILs present, the charging and aggregation properties were predominantly determined by the composition of the ILs, as they can modify the surface charge to different extents due to the distinct adsorption affinity of the IL constituents. The presented information provides useful insights for the scientific community working with LDH-IL dispersions developed for various purposes.

Acknowledgement:
D. T. was supported by the ELTE Márton Áron Special College.

References:

[1] M.A. Gebbie, A.M. Smith, H.A. Dobbs, A.A. Lee, G.G. Warr, X. Banquy, M. Valtiner, M.W. Rutland, J.N. Israelachvili, S. Perkin, R. Atkin, Long range electrostatic forces in ionic liquids, *Chem. Commun.* 53 1214-1224 (2017)
[2] D. Takács, B. Katana, A. Szerlauth, D. Sebők, M. Tomšič, I. Szilágyi, Influence of adsorption of ionic liquid constituents on the stability of layered double hydroxide colloids, *Soft Matter* 17 9116-9124 (2021)

Dóra Takács (*takacs.dora@szte.hu*) is a PhD student in the Biocolloids Research Group at the University of Szeged. Her research is concerned with development of nanocomposites and to study their colloidal properties in ionic liquid media.

László Mérai: Composite coatings with thermoresponsive wetting and visible light photoreactivity

László Mérai[1], Ágota Deák[1], László Janovák[1]
1) Department of Physical Chemistry and Materials Science, Faculty of Science and Informatics, University of Szeged, Szeged, Hungary

With the increasing demand for liquid manipulation and microfluidic techniques, surfaces with external stimuli induced real-time tunable wetting properties are getting into the focus of materials science research. In this work, we present poly(dimethylsiloxane) (PDMS) copolymer based composite coatings with thermally tunable wetting behaviour and visible-light photoreactivity. To enhance the spray-coated or doctor blade-casted PDMS with thermal responsivity, they were grafted with poly(N-isopropyl acrylamide) (PNIPAAm), applying an Activators Regenerated by Electron Transfer - Atom Transfer Radical Polymerization (ARGET-ATRP) method. As the lower critical solution temperature (LCST) of the grafted PNIPAAm chains appeared to be 34 °C, the copolymer films showed thermoresponsive, and PNIPAAm surface concentration-dependent wetting characteristics. The addition of 15 wt% visible light-active plasmonic Ag-TiO_2 photocatalyst nanoparticles (d~50 nm) enriched the coatings with photocatalytic activity, which was also proven to be temperature-dependent during methylene-blue (MB; c_0= 6.25 mM) photodegradation tests (blue LED-light, λ=405 nm) at the S/L-interface. Thanks to the real-time tunable wetting and photocatalytic properties, the presented coatings may offer a novel route towards sophisticated liquid manipulation.

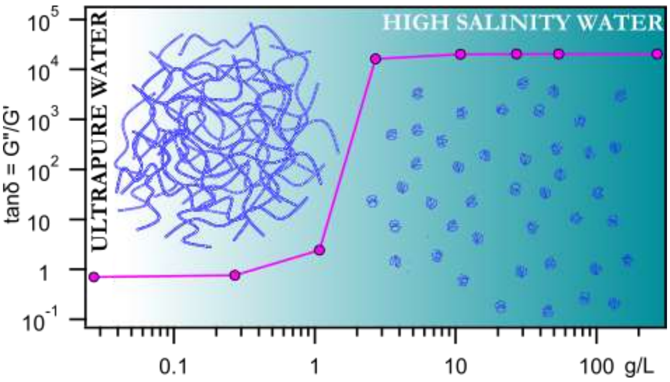
Acknowledgements:
This work was supported by the National Research, Development and Innovation Office; under Grant number GINOP2.3.2-15-2016-00013 and number GINOP-1.1.2-PIACI-KFI-2021-00193; New National Excellence Program of the Ministry for Innovation and Technology through the National Research, Development and Innovation Fund; under Grant number UNKP-20-5, number UNKP-20-4 and number UNKP20-3; Hungarian Academy of Sciences; under the János Bolyai Research Scholarship of the Ministry of Human Capacities, Hungary. Prepared with the professional support of the Doctoral Student Scholarship Program of the Co-operative Doctoral Program of the Ministry of Innovation and Technology financed from the National Research, Development and Innovation Fund.

References:
[1] L. Mérai, Á. Deák, B. Szalai, G.F. Samu, G. Katona, L., Janovák, *Expr. Polym. Lett.* 16(1) 34-51 (2022)

László Mérai (*merail@chem.u-szeged.hu*) is a PhD student at the Doctoral School of Chemistry of University of Szeged. His PhD topic is dedicated to the characterization of photoreactive composite coatings with tunable wettability. In cooperation with MOL Inc. he also gained expertise in petrol industry-related research projects, such as surfactant development for EOR applications and the utilization of refinery by-products as coating materials. His ongoing industrial project aims the development of a novel emulsion separation system for crude EOR emulsions.

Zsófia Árok: Effect of brine on the rheological properties of polymers used in enhanced oil recovery

Zsófia Árok,[1] Szilárd Sáringer,[1] Coline Bretz,[2] Sándor Puskás,[3] István Szilágyi[1]
1) Biocolloids Research Group, Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary
2) LS Instruments AG, Fribourg, Switzerland
3) MOL Hungarian Oil & Gas Plc, Szeged, Hungary



Partially hydrolysed polyacrylamide (HPAM) and ATBS (2-acrylamido-tertiary-butyl sulfonic acid) based polymers are widely applied to recover residual oil from reservoirs during polymer flooding processes in enhanced oil recovery (EOR). Although this technique showed good efficiency in oil fields of mild environmental conditions, harsh circumstances, such as elevated temperature and high salinity, may adversely affect the performance of the polymers [1].

In the present research, physico-chemical features of Flopaam 3630 and Flopaam AN125SH were investigated with various techniques at different temperatures and salt concentrations. Dependence of the hydrodynamic radii and dynamic viscosities on the ionic strength shed light on the fact that the polymer adopted an extended conformation at high salt levels, in line with findings recently reported in the literature [2]. The possible intermolecular interactions between the polymer chains were explored by rheology in both rotational and oscillatory modes under different experimental conditions. It was shown that the rheological properties of the polymer solutions change significantly at 1 g/L salinity. Accordingly, the observed pseudoplastic behaviour indicated remarkable intermolecular interactions below this threshold value, while tendencies in the parameters of the flow curves as well as in the storage and loss modulus clearly confirmed the breakup of such a coherent (gel-like) structure above 1 g/L salt concentration. Therefore, the solution behaviour of these polymers could be described by considering the presence of individual macromolecule chains without formation of gel structure at elevated salt levels. These results were further underpinned in modulated 3D cross-correlation light scattering and electrokinetic measurements performed at different salt levels. The above findings provide valuable information for the applicability of the Flopaam 3630 and the Flopaam AN125SH polymer during EOR processes in oil reservoirs of various salinity.

Acknowledgements:
This work was financially supported by the GINOP-2.3.4-15-2020-00006 project.

References:
[1] K. Liang, P. Han, Q. Chen, X. Su, Y. Feng, Comparative Study on Enhancing Oil Recovery under High Temperature and High Salinity: Polysaccharides Versus Synthetic Polymer, *ACS Omega* 4 10620–10628 (2019)
[2] A. M. Smith, A. A. Lee, S. Perkin, The Electrostatic Screening Length in Concentrated Electrolytes Increases with Concentration. *J. Phys. Chem. Lett.* 7 2157–2163 (2016)

Zsófia Árok (*vargane.arok.zsofia@szte.hu*) is a first year PhD student in the Doctoral School of Chemistry of University of Szeged. She has been involved in an industry-academic collaborative project including polymer and surfactant investigation related to enhanced oil recovery techniques. Her field of scientific interest is applicability of ionic liquids and biopolymers in chemical EOR techniques.

Zofia Krasińska-Krawet: Adsorption and aggregation properties of hydrophobically functionalized polyanions.

Zofia Krasińska-Krawet [1], Ewelina Jarek [1], Tomasz Kruk [1], Krzysztof Szczepanowicz [1], Lilianna Szyk-Warszyńska[1], Łukasz Lamch [2], Sylwia Ronka [3], Kazimiera A. Wilk [2], Piotr Warszyński [1]
1) Jerzy Haber Institute of Catalysis and Surface Chemistry, PAS, Kraków, Poland
2) Department of Engineering and Technology of Chemical Processes, Faculty of Chemistry, Wrocław University of Science and Technology, Wrocław, Poland
3) Department of Engineering and Technology of Polymers, Faculty of Chemistry, Wrocław University of Science and Technology, Wrocław, Poland

Polymeric micro- and nanocarriers have attracted broad scientific interest in recent years. However, their fabrication requires a well-designed strategy for the functionalization of polymers, which, together with the determination of their adsorption and aggregation properties, allows the development of an appropriate method of nanostructures formation.

We considered hydrophobized polyelectrolytes (HF-PE), the poly(4-styrene sulfonic-co-maleic acid) copolymers functionalized with hydrophobic alkyl side chains grafted to the backbone via the pH-labile amid or ester linkers [1]. Various techniques have been used to confirm the self-assembly of the polymers and the formation of hydrophobic domains. The analysis of differences in the dependency of interfacial tension on the HF-PE concentration and the molecular dynamics simulations showed that more tight hydrophobic domains along the PSS/MA backbone were formed for HF-PE with ester linkers [2]. The pH responsiveness was evidenced by acid and base hydrolysis in different temperatures and correlating the results with the stability of HF-PE based nanoparticles. The copolymers were adsorbed on a solid surface coated by polyelectrolyte multilayer (PEM). It was demonstrated that they form stable thin films. Moreover, the change in water structure due to their hydrophobicity was evidenced by FTIR ATR. Furthermore, contact angle analysis proved that HF-PE modified the wetting of the PEM surface [2].

Our research demonstrated that HF-PE based on PSS/MA copolymers are a promising material for creating nanocarriers for the controlled release of hydrophobic substances and thin polymer films modifying the surface properties of materials.

Acknowledgements: The work was supported by the NCN project 2017/25/B/ST4/02450.

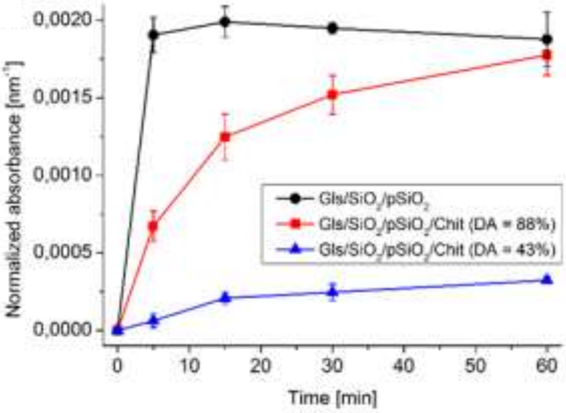
References:

[1] Ł. Lamch, S. Ronka, P. Warszyński and K. A. Wilk, *Journal of Molecular Liquids* 308 112990 (2020)
[2] E. Jarek, Z. Krasińska-Krawet, T. Kruk, Ł. Lamch, S. Ronka, K.A. Wilk and P.Warszyński, *Colloids and Interfaces* 5 3. (2021)

Zofia Krasińska-Krawet (*zofia.krasinska-krawet@ikifp.edu.pl*) is a PhD student in Nanostructures of Soft Matter Group at Jerzy Haber Institute of Catalysis and Surface Chemistry Polish Academy of Sciences. She has participated in projects carried out in cooperation of Polish and foreign scientific units. Her research topics cover the adsorption of proteins on the surface of thin polymer films, doped thin conductive films, and the aggregative properties of polymers. In her limited free time, she explores the knowledge of keeping alive and developing the young specimen of Homo sapiens and performs in vivo tests on her new research theories.

Péter Márton: Permeability of chitin and chitosan nanolayers

Péter Márton[1], Örs Tamás Nagy[2], Dorina Kovács[1], Beáta Szolnoki[1], János Madarász[1], Norbert Nagy[3], Gabriella Stefánia Szabó[2], Zoltán Hórvölgyi[1]
1) Budapest University of Technology and Economics, H-1111 Budapest, Hungary
2)Babeş-Bolyai University, Faculty of Chemistry and Chemical Engineering, RO-400028, Cluj-Napoca, Romania
3) Institute for Technical Physics and Materials Science, Centre for Energy Research, H-1525 Budapest, Hungary



Both chitin and chitosan are natural copolymers of D-glucosamine and *N*-acetyl-D-glucosamine units. The percentage of the *N*-acetyl-D-glucosamine units within the polymer chain is called the degree of acylation (DA) of the material, which is high for chitin and low for chitosan. In this research, chitosan coatings were prepared on glass and zinc substrates by dip-coating method. The coatings were chemically modified with acetic anhydride to increase their DA from ca. 43% (chitosan) up to ca. 98% (chitin). The DA of the coatings were determined by infrared spectroscopy (ATR-FTIR technique). The structural properties of the chitosan layers were investigated by UV-Vis spectrophotometry and X-ray diffraction. The surface polarity and morphology were studied by wettability measurements and microscopic methods (SEM and AFM).

A multilayered model coating on glass substrate was developed for studying the permeability of chitosan nanolayers [1]. Diffusion of Rhodamin 6G molecules across the chitosan layer from its aqueous solution was investigated by measuring the transported amount of dye molecules as a function of time (see figure). Polarization and electrochemical impedance spectroscopic tests were also used to characterize the permeability of the chitosan layer deposited on Zn electrodes [2]. It was found that the acylation increases the permeability which we explained in terms of the structural changes in the chitosan nanolayers.

References:

[1] Dabóczi, M., Albert, E., Agócs, E., Kabai-Faix, M., & Hórvölgyi, Z. Bilayered (silica-chitosan) coatings for studying dye release in aqueous media: The role of chitosan properties. *Carbohydrate Polymers* 136 137–145 (2016)

[2] Márton, P., Albert, E., Nagy, N., Tegze, B., Szabó, G. S., & Hórvölgyi, Z. Chemically modified chitosan coatings: Wetting and electrochemical studies. *Studia Universitatis Babes-Bolyai Chemia*, 65(3) 63–79 (2020)

Péter Márton (*marton.peter@vbk.bme.hu*) is a PhD student in the George A. Olah Doctoral School of Chemistry and Chemical Technology of Budapest University of Technology and Economics. He is doing his work at he Centre for Colloid Chemistry, where he has been studying the physical and properties of chitosan thin films since 2018 Recently, he has been dealing with the acylation of these types of coatings and the study of changes in their properties. He is also interested in the physical chemistry of surfaces, likes to teach, cook, and reading fantasy novels and detective stories in his free time.

Alexandra Kovács: Protein-polymer complex colloidal carriers: synthesis and optimization

Alexandra N. Kovács[1], Edit Csapó[1]
1) MTA-SZTE Lendület "Momentum" Noble Metal Nanostructures Research Group, Interdisciplinary Excellence Center, Department of Physical Chemistry and Materials Science, University of Szeged, Szeged, Hungary

The development of effective drug-delivery carriers with enhanced dose loading is still in the center of interest. The polymer-based structures imply a potential carrier candidate for the delivery of different active compounds with enhanced amount.

Our study mainly focusing on the design of optimized protein-based complex carriers, that can enhance dissolution rate and facilitate the absorption of different drugs (antioxidant, non-steroidal anti-inflammatory drugs), thereby reducing the risk of adverse effects. The pH-dependent nature of the interactions between the macromolecules and the active compounds were studied in detail.[1] After the detailed investigation, different drug compounds were encapsulated into the above mentioned drug delivery carriers, and the characteristic features (size, morphology, protein structure, stability) of the protein-based complex particles were investigated by circular dichroism spectroscopy, dynamic light scattering, and turbidity and transmission electron microscopy measurements. Moreover, the effective applicability of the drug-loaded structures (*in vitro* dissolution and specific permeability studies) were studied for both bovine (BSA) and human serum albumin (HSA)-based particles with optimized drug content. [2] In the proposed presentation, the tocopherol-loaded serum albumin/PLGA and the ibuprofen-loaded albumin/hyaluronic acid systems are compared and the preparation conditions and the detailed characterization is discussed in detail.

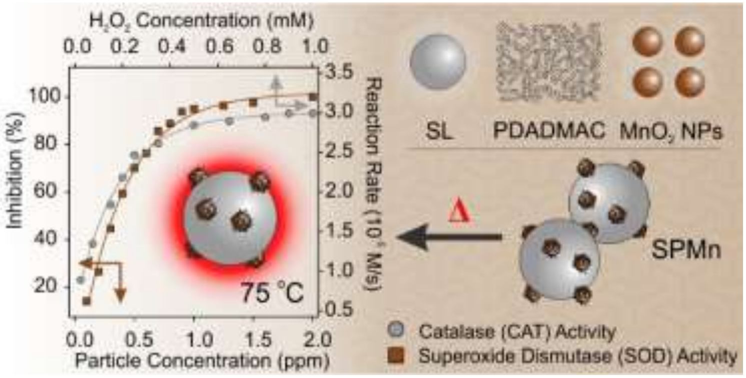
Acknowledgements:
The research was supported by the National Research, Development, and Innovation Office -NKFIH through FK131446 project. A. N. Kovács thanks the financial support to the NTP-NFTÖ-21-B-0134 program.

References:
[1] A. N. Kovács, N. Varga, Á. Juhász, E. Csapó: Serum protein-hyaluronic acid complex nanocarriers: Structural characterisation and encapsulation possibilities, *Carbohydrate Polymers 251 117047 (2021)*
[2] A. N. Kovács, G. Katona, Á. Juhász, Gy. T. Balogh, E. Csapó: Albumin-hyaluronic acid colloidal nanocarriers: Effect of human and bovine serum albumin for intestinal ibuprofen release enhancement, *Journal of Molecular Liquids 351 118614 (2022)*

Alexandra N. Kovács (*kovacsal@chem.u-szeged.hu*) is a supervised PhD student in the Doctoral School of Chemistry of University of Szeged. She has been involved in projects related to the effective encapsulation of antibiotics, non-steroidal anti-inflammatory drugs, and vitamins into protein-based carrier systems.

Nizar B. Alsharif: Biocatalytic Hybrids of Manganese Oxide and Sulfate Latex Particles

Nizar B. Alsharif[1], Katalin Bere[1], Gergely F. Samu[2], Istvan Szilagyi[1,2]
1) MTA-SZTE Lendület Biocolloids Research Group, Department of Physical Chemistry & Materials Science, University of Szeged, 6720-Szeged, Hungary
2) Interdisciplinary Excellence Center, Department of Physical Chemistry and Materials Science, University of Szeged, 6720-Szeged, Hungary



Nanozymes are nano-structured materials with enzyme-like biocatalytic potential, and are regarded as versatile alternatives to natural enzymes due to structural stability, biocatalytic activity, and high colloidal stability over a wide range of experimental conditions including the pH and temperature, where natural enzymes often lose activity as a result of inherent structural instability.[1] Here, the preparation of composites of manganese oxide (MnO_2) and sulfate-functionalized polystyrene latex (SL) particles as antioxidant composites was achieved via heteroaggregation of the two particles.[2] Negatively charged MnO_2 particles were initially functionalized with cationic PDADMAC polyelectrolyte, and the adsorption of adequate amount PDADMAC led to charge reversal and formation for positively charged MnO_2 particles to enable their immobilization on negatively charged SL particles, which led to the formation of negatively charged, neutral, and positively charged SL-PDADMAC-MnO_2 (SPMn) composites. The charge neutralization of the resulting SPMn resulted in aggregated dispersions, while stable samples were obtained when the composites possessed sufficiently high negative and positive charge, well below and above the charge neutralization point, respectively. The antioxidant assays revealed that the functionalization of MnO_2 with PDADMAC and the subsequent immobilization of MnO_2 onto SL particles did not compromise their catalase (CAT) and superoxide dismutase (SOD) activities. In addition, prolonged thermal treatment at high temperatures did not compromise the enzymatic activities for both bare and immobilized MnO_2. The TOC figure demonstrates the formulation and the enzymatic activity of bare MnO_2 as well as the resulting SPMn composites, which are foreseen to be a potential candidate as an antioxidant material for the efficient scavenging of reactive oxygen species, even under harsh conditions, where natural antioxidants undergo loss of catalytic activity.

References:
[1] Alsharif, N. B.; Samu, G. F.; Sáringer, S.; Muráth, S.; Szilagyi, I., A colloid approach to decorate latex particles with Prussian blue nanozymes. *J. Mol. Liq.* 309 113066 (2020)
[2] Alsharif, N. B.; Bere, K.; Sáringer, S.; Samu, G. F.; Takacs, D.; Hornok, V.; Szilágyi, I., Design of hybrid biocatalysts by controlled heteroaggregation of manganese oxide and sulfate latex particles to combat reactive oxygen species. *J. Mat. Chem. B* 9 4929-4940 (2021)

Nizar B. Alsharif (*nizar.alsharif@chem.u-szeged.hu*) is a 4th-year Ph.D. student at MTA-SZTE "Lendület" Biocolloids Research Group at the Department of Physical Chemistry and Materials Science at the University of Szeged, where he earned his M.Sc. in Chemistry as well. His work mainly concerns the synthesis of enzyme-mimicking nanoparticles and subsequent development of nanocomposites with high colloidal stability and antioxidant potential.

Péter Nagy: Potential sources, synthesis methods and industrial applications of waste generated graphene-based nanocomposites

Péter Nagy[1], Tamás Szabó[1], Badrul Mohamed Jan[2], Rabia Ikram[2]
1) Department of Physical Chemistry and Materials Science, University of Szeged, Aradi vértanúk tere 1, Szeged 6720, Hungary
2) Department of Chemical Engineering, University of Malaya, 50603, Kuala Lumpur, Malaysia

One of the most urgent worldwide problems of the world is the waste treatment, burdening all human activities from households to large industries, which increases in parallel with the overpopulation. In this presentation, we overview different type of waste sources which can be easily converted to carbon particles for large scale composite production by nanotechnology. In the past decade, graphene-based nanocomposites and carbonaceous composite materials gain significant interest in terms of potential environmental applications. Due to its versatile composite and film forming capabilities, graphene-based materials such as graphitic carbon, graphene, graphene-oxide and reduced graphene-oxide can act both as matrix or filler in composite materials. Moreover, the sp^2 hybrid state of carbon atoms in the honeycomb like lattice structure prove remarkable electric and conductive characteristics, which can be heavily influenced by the degree of oxidation matrix-filler ratio and the type of the other components. In addition, carbonaceous materials are applied to improve the mechanical properties of structural materials for long time. Traditional applications like membrane filtering, adsorption processes can be also built on waste-derived graphene-based nanocomposites. In terms of electrical applications, due to the bandgap influenced by the composition the photocatalysis is also a potential way to reuse graphitic materials. In this interesting approach, we would like to highlight how the valorization of waste materials can prove a cost-effective and environmental friendly solution in the green synthesis of various carbon based-nanocomposites.

Acknowledgements:

The project no. 124851 has been implemented with the support provided from the National Research, Development, and Innovation Fund of Hungary (NKFIH), financed under the FK funding scheme. We also thank the support of the NKFIH (project No. 2019-2.1.7-ERA-NET-2021-00029) in the frame of supporting the AtomDec Consortium by the Visegrad Group-Japan 2021 Joint Call on Advanced Materials. Support of the János Bolyai Research Scholarship from the Hungarian Academy of Sciences is also acknowledged.

References:

[1] S. Sunahiro, K. Nomura, S. Goto, K. Kanamaru, R. Tang, M. Yamamoto, T. Yoshii, J. Kondo, Q. Zhao, A. Nabi, R. Crespo, D. Di Tommaso, T. Kyotani, H. Nishihara, (2021). *J. Mater. Chem. A,* 9 *14296-14308* (2021)
[2] H. Nishihara, T. Simura, S. Kobayashi, K. Nomura, R. Berenguer, M. Ito, M. Uchimura H. Iden K. Arihara, A. Ohma, Y. Hayasaka, T. Kyotani. *Adv. Funct. Mater.,* 26 6418-6427 (2016)
[3] Nomura K.; Nishihara H.; Asada T.; Kobayashi N.; Kyotani T. *Energy Environ. Sci.* 12 1542-1549 (2019)

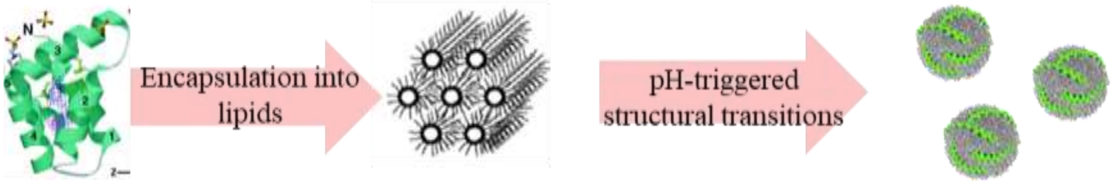
Péter Nagy *(bigpetthegreat01@gmail.com)* is a PhD student in the Doctoral School of Chemistry of University of Szeged. He started his training in 2021. He completed both his Bsc and Msc in Szeged in the field of chemistry. His research interest is carbonaceous materials mostly graphene based ones, including nano-sized composites. His work covers a wide range of colloid science from the colloid stability, interfacial phenomena till the potential applications of graphene based carbons.

Poster Presentations

PP-1 – PP-19

Owais Hameed: Design of antimicrobial protein-lipid complexes: From purification to delivery of antimicrobial peptides derived from cytotoxic T cells

Owais Abdul Hameed[1,2], Mark Gontsarik[2], Michael Walch[1], Stefan Salentinig[2]
1) Anatomy Unit, Department of Oncology, Microbiology and Immunology, Faculty of Science and Medicine, University of Fribourg, Switzerland
2) Department of chemistry, Faculty of Science and Medicine, University of Fribourg, Switzerland



There is an urgent need to develop new antimicrobial materials to outsmart bacteria that are increasingly becoming resistant to conventional antibiotics. Natural antimicrobial peptides that can compromise the barrier function of bacteria cell membranes provide a promising alternative to conventional antibiotics. However, their poor stability in biological media is a major drawback for pharmaceutical application.

This presentation demonstrates the design of pH-responsive dispersed lipid self-assemblies as functional nanocarriers for antimicrobial peptides. The nanocarriers were characterized at different composition and pH values using small angle X-ray scattering, dynamic light scattering, zeta potential, encapsulation efficiency and their biological activity *in vitro* and *in vivo.*

The pH-triggered structural transitions allowed encapsulation of the peptides showing change in size and zeta potential at pH 7. Biological *in vitro* assays showed high activity against *Escherichia coli* and *S. aureus* with the positively charged nanocarriers at pH 5.0, while negligible antimicrobial activity was observed at pH 7.0 for the negatively charged nanocarriers. This was translated into *in vivo* surgical infections caused by *S. aureus*, revealing their activity in the skin model. The ability to switch their biological activity “on” and “off” in response to changes in pH has potential to focus the antimicrobial peptides’ action to areas of specific pH in the body. The delivery of the antimicrobial peptide to the bacterial membrane presents a promising strategy against various multi drug resistant bacteria while protecting the beneficial microbiome in the body and eliminating adverse effects.

References:

[1] Mark Gontsarik, From Structure to Function: pH-Switchable Antimicrobial Nano-Self-Assemblies, *ACS Applied Materials & Interfaces* 11 (3) 2821-2829 (2019)

[2] Mahsa Zabara, Multifunctional Nano-Biointerfaces: Cytocompatible Antimicrobial Nanocarriers from Stabilizer-Free Cubosomes, Advanced Functional Materials doi: 10.1002/adfm.201904007 (2019)

Balázs Borbás: Synthesis and Characterization of Upconverting Nanoparticles in Suspensions and Chitosan-Matrix Thin Films

Balázs Borbás[1], Borbála Tegze[1], Adrien Paudics[1], Miklós Kubinyi[1], Zoltán Hórvölgyi[1]
1) Budapest University of Technology and Economics, Budapest, Hungary

Recently, the application of upconverting nanoparticles (UCNPs) in photodynamic therapy and solar cells has an ever-growing potential. Via anti-Stokes emissions shown by UCNPs near-infrared light is converted into visible and UV light. The emitted photons can later be absorbed by dye molecules, and the dye molecules then transfer this energy to a semiconductor material, e.g. TiO_2. In our research, we focused mainly on the effect UC emissions have on fluorescent dye molecules and the photocatalytic effects of titania. $NaYF_4$: 20% Yb^{3+}, 0.5% Tm^{3+} upconverting nanoparticles were prepared via solvothermal synthesis. Both ethanolic and water-based suspensions showed intensive anti-Stokes emissions under NIR excitation. UCNP-containing thin film model systems were prepared using water-based chitosan-matrix and spin-coating method. The thin coatings showed significant UC-emission intensities.

Experiments on the upconversion induced photodegradation of R6G via titania nanoparticles were conducted, the UCNPs showed energy transfer with both R6G molecules (Figure 1) and TiO_2 nanoparticles under 980 nm excitation.

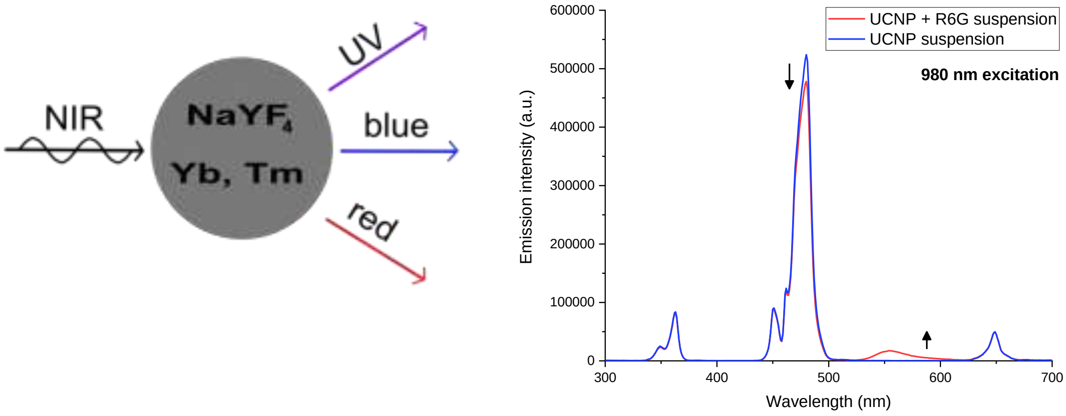


Figure 1. The upconversion phenomenon and the energy transfer between UCNPs and R6G molecules

Balázs Borbás (*borbasbalazs@icloud.com*) is an undergraduate chemical engineering student at Budapest University of Technology and Economics in Budapest, Hungary. He works there at the Centre for Colloid Chemistry research group, investigating upconverting nanoparticles and their nano-scale coatings. His hobbies include brewing pour-over coffee and reading (fantasy preferred over textbooks).

Teona Teodora Borovic: A thermodynamic study: Effect of cationic structure of ionic liquids on their aggregation and micellization properties

Teona Teodora Borović[1], Snežana Papović[1], Jovana Panić[1], Nikolett Cako Bagány[1], Slobodan Gadžurić[1], Marija Bešter-Rogač[2], Milan Vraneš[1]
1) Department of Chemistry, Biochemistry and Environmental Protection, Faculty of Sciences, University of Novi Sad, Trg Dositeja Obradovića 3, 21000 Novi Sad, Serbia
2) Faculty of Chemistry and Chemical Technology, University of Ljubljana, Vecˇna pot 113, 1000 Ljubljana, Slovenia

In the past decades, ionic liquids (ILs) have often been the subject of research and they are usually called designer compounds. One particular group of ILs are surface-active ionic liquids (SAILs). They have a structure where a cation or anion consists of a charged hydrophilic head and a hydrophobic tail. This structure of SAILs makes them similar to conventional surfactants and represents a good model of the system for thermodynamic studies of the micellization process. In this paper, we investigated the influence of the structural variation of the heterocyclic rings of SAIL with a dodecyl alkyl chain on the thermodynamic parameters of micellization. The following ionic liquids were synthesized: 1-dodecylimidazolium bromide ($[C_{12}im]Br$), 3-dodecylthiazolium bromide ($[N\text{-}C_{12}thiaz]Br$), N-dodecylpyridinium bromide ($[N\text{-}C_{12}\text{-}py]Br$). The structures of the synthesized ionic liquids were confirmed by NMR and IR spectroscopy. The micellization was studied by isothermal titration calorimetry (ITC). The experimental data from ITC measurements were analyzed using an improved mass action model to obtain values of the critical micelle concentration (cmc), the degree of counterion binding (β), the average aggregation number (n), the standard heat capacity ($\Delta_M c_p^\theta$), enthalpy ($\Delta_M H^\theta$), entropy ($\Delta_M S^\theta$) and Gibbs free energy ($\Delta_M G^\theta$) of micellization. The average aggregation number decreases in the following order: [N-C12-py] > [N-C12thiaz]Br > $[C_{12}im]Br$. The micellization process is spontaneous in all systems and the increase in entropy is the driving force at all temperatures.

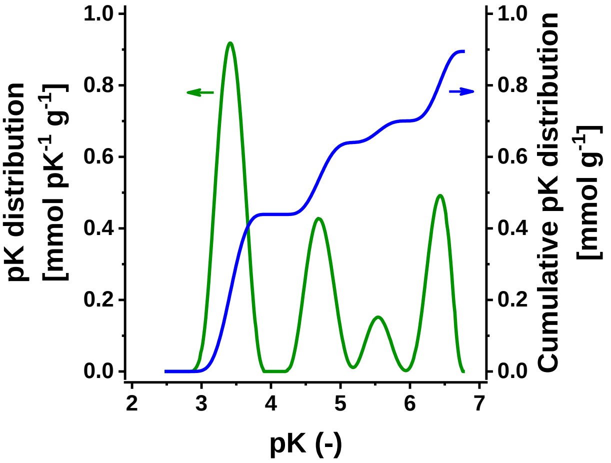
References:

[1] T. Welton, Room-temperature ionic liquids. Solvents for synthesis and catalysis, Chem. Rev. 99 (8), 2071–2084 (1999).

Teona Teodora Borović (*teona@dh.uns.ac.rs*) graduated in Chemistry in 2019, and then, in 2020 she obtained Master's degree in Chemistry at the University of Novi Sad, Faculty of Sciences. She is a second year student of doctoral studies in chemistry at the Faculty of Sciences in Novi Sad, from 2020 to present. Currently, she is employed as a Researcher assistant at the same Faculty. Her research fields are green chemistry, synthesis and investigation of physicochemical and solvation properties of ionic liquids.

Anna Bulátkó: Investigation of the surface chemistry of graphene oxide and reduced graphene oxide

Anna Bulátkó[1], Miklós Mohai[2], Krisztina László[1]
1) Budapest University of Technology and Economics, H-1111 Budapest, Hungary
2) Research Centre for Natural Sciences, H-1117, Budapest, Hungary



For many years, graphene oxide (GO) has been mainly considered as an intermediate of wet chemical graphene production. Today, however, graphene oxide itself has gained its own well-deserved recognition and its application potential is continuously expanding. Although in the manufacture of GO-based electrodes and optoelectronic devices, GO is used in a solid, dry form, the processing often happens in a suspended form. For the applicability of graphene oxide derivatives, it is essential to know their surface properties either or both in dry and wet conditions. These properties are influenced by the graphite precursor, the wet exfoliation method and any further treatments applied.

GO samples were prepared by a modified Hummers method [1,2] from two natural graphite precursors of different particle size. Ascorbic acid was applied to obtain reduced graphene oxides (rGOs). The alkaline pH was set by NH_4OH [3] and KOH. The aim of this study was to investigate the effect of the precursor material, its particle size and the reducing medium on the morphology and surface chemical properties of the products using laser assisted particle size analysis (PSA), low temperature nitrogen adsorption, Raman spectroscopy, photoelectron spectroscopy (XPS), powder X-ray diffraction (XRD). Beside XPS the surface chemistry was also studied by potentiometric titration. The pKa distribution and the concentration of the surface functionalities (see figure) were derived with the SAIEUS_pK program [4].

References:

[1] Hummers, W.S., Jr.; Offeman, R.E. Preparation of graphitic oxide. *J. Am. Chem. Soc.,* 80 1339 (1958)

[2] Marcano, D.C., Kosynkin, D.V., Berlin, J.M., Sinitskii, A., Sun, Z., Slesarev, A., Alemany, L.B., Lu, W., Tour, J.M. Improved synthesis of graphene oxide. *ACS Nano,* 4 4806–4814 (2010)

[3] Fernández-Merino, M.J., Guardia, L., Paredes, J.I., Villar-Rodil, S., Solís-Fernández, P., Martínez-Alonso, A., Tascón, J.M.D. Vitamin C Is an Ideal Substitute for Hydrazine in the Reduction of Graphene Oxide Suspensions. *J. Phys. Chem. C,* 114 6426–6432 (2010)

[4] Jagiello, J. Stable numerical solution of the adsorption integral equation using splines. *Langmuir,* 10 2778–2785 (1994)

Anna Bulátkó (*bulatko.anna@edu.bme.hu*) is a PhD student in the George A. Olah Doctoral School of Chemistry and Chemical Technology of Budapest University of Technology and Economics. She has been a member of the Surface Chemistry Research Group since 2017, where she initially studied the drug release of responsive polymer hydrogels. During her PhD work she is dealing with polymer based porous carbon systems and their applicability. In her free time, she watches old classic movies, reads war books, and loves gardening.

Alexandra M. Chiriac: Chemical interface damping of the surface plasmon resonance of single silver nanoparticles due to amino acid adsorption

Alexandra M. Chiriac[1], Ștefania D. Iancu[1], Andrei Ștefancu[1], Nicolae Leopold[1]
1) Faculty of Physics, Babeș-Bolyai University, 400084 Cluj-Napoca, Romania

Excited plasmons in metallic nanoparticles decay via radiative and nonradiative processes. Chemical interface damping (CID) represents a decay mechanism of the coherent electron oscillation, based on electron scattering into available adsorbate energy states at the nanoparticle surface. Experimentally, the CID of the surface plasmon resonance (SPR) modes of single nanoparticles are monitored by dark field microscopy and can be quantified through the shift and broadening of the SPR modes.

Our study aims to highlight CID effects after the chemisorption of leucine, phenylalanine and cysteine amino acids to the silver nanoparticle (AgNP) surface.

A dark field microscope coupled with hyperspectral imaging (CytoViva) was used for measuring the SPR position and half width at half maximum (hwhm) of the same single AgNPs before and after adding the target analytes.

By adding leucine to the AgNPs the SPR band shifts significantly (p=0.05) from 538.2 to 530.1 nm. However, this spectral shift is not assigned to a CID effect because no broadening of the hwhm is observed. Further, when Ca^{2+} is added to the AgNPs modified with leucine, a significant (p=0.008) red shift (from 530.1 to 551.8 nm), together with a broadening of the SPR band is observed (p=0.05), indicating a CID effect. Lastly, we found that Cl^- does not influence the SPR band of the AgNPs in the presence of leucine.

When phenylalanine is added to AgNP, a red shift of the SPR band from 544.2 to 560.5 nm is observed (p=0.002), without change in the hwhm. After the addition of Ca^{2+} a further shift of the SPR band is detected (577 nm), together with a broadening of the SPR band. Similarly, Cl^- does not influence the SPR band of the AgNPs in the presence of phenylalanine.

The adsorption of cysteine leads to a significant red shift (from 537.7 to 550.5 nm) together with an enlargement of the SPR band. It was found that Ca^{2+} and Cl^- have no influence on the adsorption of cysteine to the Ag surface, no changes in the SPR band being observed.

To summarize, our results show that the chemisorption of leucine and phenylalanine is promoted by Ca^{2+}, leading to a CID effect, whereas cysteine chemisorbs spontaneously to the AgNP surface and leads to the appearance of the CID effect.

Alexandra M. Chiriac (*alexandra.maria.chiriac@stud.ubbcluj.ro*) is a master's student in the department of Biophysics and Medical Physics at the Babeș-Bolyai University in Cluj-Napoca. She is interested to understand better molecule-metal interactions at the single particle level by chemical interface damping studies.

Dániel Fülöp: Interfacial properties of PLGA nanoparticles

Dániel Fülöp[1,2]; Éva Kiss[1]; Gergő Gyulai[1]
1) Eötvös Loránd University, Laboratory of Nanostructures and Interfaces, Pázmány Péter sétány 1/A, H-1117, Budapest, Hungary
2) Eötvös Loránd University, Hevesy György Doctoral School of Chemistry, Pázmány Péter sétány 1/A, H-1117, Budapest, Hungary

Poly(lactic-co-glycolic acid) (PLGA) has proved to be an excellent material for drug carrier nanoparticle fabrication due to the controlled and sustained release properties, low toxicity and biocompatibility. In this study, the interfacial properties of surface modified PLGA nanoparticles were investigated. Amphipathic, PEO-PPO-PEO, triblock Pluronic copolymer (F127) was used for surface modification to enhance colloidal stability.

The nanoparticles were prepared using the nanoprecipitation method. The prepared systems had an average diameter of 150 nm with a narrow size distribution and –23.6 mV electrophoretic potential.

The adsorption of nanoparticles at the air-water interface of a pendant droplet was investigated using optical contour analysis in the temperature (*T*) range of 25 °C to 50 °C at various nanoparticle concentrations.

Equilibrium surface tension values (γ_∞) were determined from the measured surface tension (γ) vs time (*t*) curves at various temperatures. A break point was found at 37 °C in the increase of equilibrium surface tensions with temperature (Figure 1). This change was identified as the temperature dependent gelation of the Pluronic layer of the particles at the air-water interfaces.

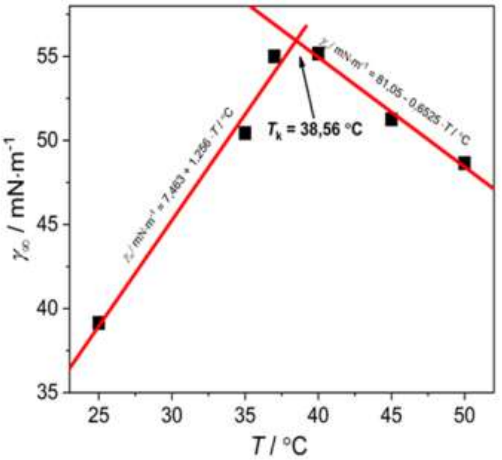
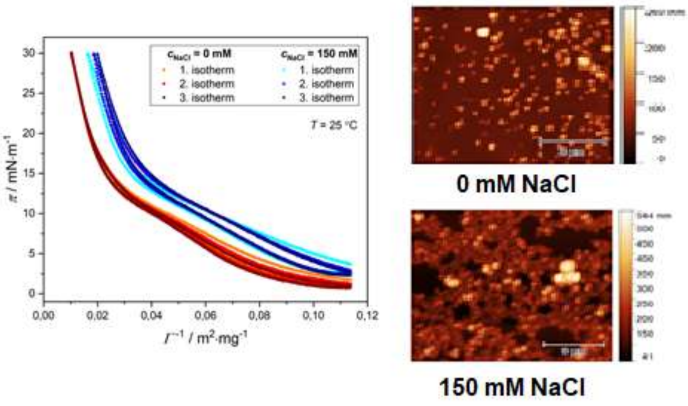


Figure 1. Temperature dependence of equilibrium surface tensions

Langmuir balance technique was also used to investigate the interfacial properties of the nanoparticles. The surface pressure- inverse surface concentrations (*Γ*) isotherms were determined in the presence of 0 and 150 mM electrolyte at 25 °C (Figure 2).



0 mM NaCl

150 mM NaCl

Figure 2. Langmuir isotherms of PLGA-F127 nanoparticles at 0 and 150 mM NaCl (left). AFM images of PLGA-F127 layers at 25 mN·m^{-1}surface pressure (right)

The hysteresis of isotherms and the difference between the successively measured isotherms were small at 0 mM NaCl concentration. This suggests that the nanoparticles form a stable layer in the air-water interface. In the presence of electrolyte, a different behavior was observed. The isotherms were shifted towards higher inverse surface concentrations. Also, the detected surface pressure values were significantly larger in the presence of electrolyte. This phenomenon suggests the interfacial aggregation of particles in the presence of electrolytes. This assumption was proven by atomic force microscopy (Figure 2).

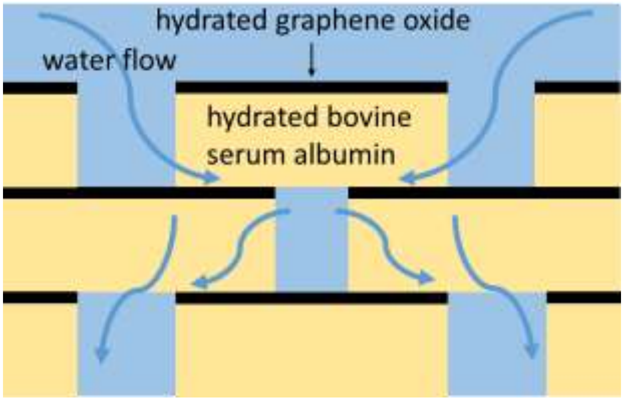
The gained results could help in the rational development of drug delivery systems as well as biocompatible and biodegradable Pickering emulsion stabilizers for medical applications.

Acknowledgements:
These studies were supported by grant (VEKOP-2.3.3-15-2017-00020 and VEKOP-2.3.2-16-2017-00014) from the European Union and the State of Hungary, co-financed by the European Regional Development Fund. This work was completed in the ELTE Institutional Excellence program (1783-3/2018/FEKUTSTRAT) supported by the Hungarian Ministry of Human Capacities.

Dániel Fülöp is a PhD student in the Hevesy György Doctorial School of Chemistry of Eötvös Loránd University at Budapest, Hungary. In his doctorial work he develops functionalized polymer nanoparticle systems, such as core-shell and Janus nanoparticles using microfluidic devices. He has also been involved in collaborative academic projects such as the investigation of amyloid formation of a small protein and the development of a tuberculosis vaccination. Recently, he started working with fluorescent carbon quantum dots.

Péter Gyenes: Graphene oxide / bovine serum albumin composite ultrafiltration membranes

Péter Gyenes[1], Hala Roumia[1], Kadosa Sajdik[1], Alberto Tiraferri[2], Tamás Szabo[1]
1) Department of Physical Chemistry and Materials Science, University of Szeged, Rerrich B. tér 1, Szeged, H-6720, Hungary
2) Department of Environment, Land and Infrastructure Engineering, Politecnico di Torino, Corso Duca degli Abruzzi 24, Torino, 10129, Italy



The freshwater scarcity represents an ever-growing problem in today's world. The remaining freshwater often gets contaminated with pathogens, heavy metals or toxins. It is important to efficiently and cost-effectively get rid of these contaminants. Many traditional ways only offer partial solution like sand bed filtration or have special geological requirements like river bed filtration. The more modern ways like advanced oxidation processes have high energy consumption.

Membrane filtration can offer a cost-effective and efficient alternative. Most of the membranes used in water filtration are thin film composite membranes. They are made from different layers of polymers. However, their pore diameter has a large deviation [1], which makes it difficult to filter out a particle completely without having to choose a very small pore diameter. A better solution is to control the pore size on a nanoscale level. One way to achieve this is by using graphene oxide composite membranes. Graphene oxide membranes proven their worth many times in water filtration, but tuning their interlayer distance would give them more flexibility. One of the best ways to do it, is by intercalating particles between the layers of graphene oxide.

Bovine serum albumin can be one such particle, that can increase the interlayer distance of graphene oxide plates as seen in ToC figure. The is composite made from graphene oxide suspension and bovine serum albumin solution. The resulting suspension was filtered through a support membrane to get the composite membrane. The manipulation of interlayer distance in graphene oxide composite membranes warrants further research.

References:
[1] N. Hilal, H. Al-Zoubi, N.A. Darwish, A.W. Mohammad, Characterisation of nanofiltration membranes using atomic force microscopy, *Desalination* 177 187-199 (2005)

Péter Gyenes (gyenespeter5@gmail.com): I am doing chemistry masters at the University of Szeged. I do research in the colloid layers laboratory with my fellow colleagues. I did graphene oxide synthesis and reduction. I studied ultrafiltration and nanofiltration membranes. I made thin films with layer-by-layer method and studied graphene oxide / protein systems. In my spare time I do an another form of chemistry: cooking.

Georgiana Ion: Raman-related effects on carotenoids: a systematic study

Georgiana Ion[1], Stefania D. Iancu[1], Nicolae Leopold[1]
1) Faculty of Physics, Babeș-Bolyai University, Cluj-Napoca, Romania

Serum carotenoid levels are often associated with various pathologies in the human body. Their contribution to the Raman or surface-enhanced Raman scattering (SERS) spectra of serum or plasma can be used for diagnosis of disease. However, the assignment of the carotenoid bands in plasma or serum is not clear, some studies mentioning carotenoid bands as Raman bands, whereas others as SERS peaks.

Our study represents a systematic approach for the accurate assignment of the nature of the carotenoid signal from serum and plasma samples as resonance Raman, SERS, or SERRS (Surface-enhanced resonance Raman scattering). In this regard, we acquired Raman and SERS spectra of a mixture of different carotenoids, such as β-carotene and norbixin, and the most common metabolites from the human blood (uric acid, xanthine and hypoxanthine). As metallic substrates, we used silver (AgNPs) and gold nanoparticles (AuNPs), with surface plasmon resonance (SPR) at 420 nm and 520 nm, respectively. The spectra were acquired using different laser lines (442 nm, 532 nm, 633 nm), which fit either the resonance condition of the carotenoids (442 nm and 532 nm) or the excitation of the surface plasmons of the metallic nanoparticles (532 nm for AgNPs and 633 nm for AuNPs). No enhancement of the Raman bands characteristic of carotenoids was observed in the presence of the metallic nanoparticles.

The Raman spectra of the carotenoids/purine metabolites solution acquired with the 442 and 532 nm laser lines show the characteristic Raman bands of carotenoids (1000-1010, 1145-1165 and 1500-1535 cm^{-1}) and no Raman bands of the purine metabolites. When using the 633 nm laser line, no Raman bands were observed. Further, we added AgNPs and AuNPs to the solution and acquired SERS spectra using the 442, 532 and 633 nm laser lines. No significant difference was observed compared to the Raman spectra of the same solution. However, by modifying the nanoparticles with adions (Ca^{2+} and Cl^-), the vibrations of the purine metabolite molecules were enhanced, but no enhancement of the carotenoid Raman bands was observed.

By using the 442 nm laser line that fits the resonance condition of the carotenoids, but does not excite the SPR of the metallic nanoparticles, the Raman bands of the carotenoids are observed with no enhancement from the nanoparticles.

When exciting the SPR of the metallic nanoparticles with a laser line that fits the resonance condition of the carotenoids, 532 nm laser line, the SERS bands of the purine metabolites were observed together with the vibrations characteristic to carotenoids, but no enhancement of the carotenoid Raman bands was detected. However, when using a laser line that falls out of the resonance of carotenoids but excites the SPR (633 nm laser line), the spectrum was dominated by the purine metabolite bands and no bands characteristic to carotenoids were observed.

Concluding, our study has demonstrated that the carotenoid bands in serum or plasma represent a Raman resonance effect and not a SERS contribution.

Georgiana Ion *(georgiana.ion@stud.ubbcluj.ro)* is a student in the Medical Physics department of the Faculty of Physics, Babes-Bolyai University in Cluj-Napoca, Romania. Her domain of interest in research is the study of biomolecules through microscopy and spectroscopy methods, in particular Raman and SERS, and the interaction between nanoparticles and molecules. In her free time, she likes traveling, hiking and reading.

Jin Hau Lew: Effect of polymer chemistry on polyacrylamide adsorption onto calcium carbonate

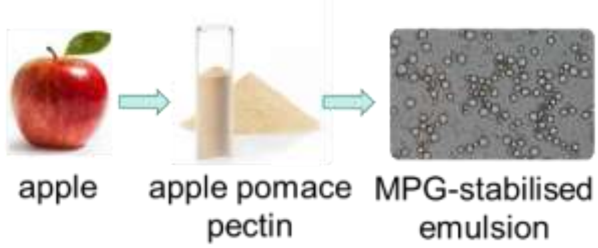
Jin Hau Lew[1]*, Omar K. Matar*[1]*, Erich A. Müller*[1]*, Myo Thant Maung Maung*[2] *and Paul F. Luckham*[1]
1) Department of Chemical Engineering, Imperial College London, London SW7 2AZ, UK
2) PETRONAS Research Sdn. Bhd., Bandar Baru Bangi, Selangor 43000, Malaysia

Carbonate rock strengthening using polymer is a strategy to prevent excessive fines migration during oil and gas production and to maintain well stability. Therefore, it is imperative to understand the effect of polymer chemistry on any strengthening. Here, we present the effect of polyacrylamide (PAM) chemistry from the perspective of polymer charge density, crosslinking and functional group through an adsorption study of PAM onto calcium carbonate ($CaCO_3$) particles. First, hydrolysed polyacrylamide (HPAM) of three different charge densities (10%, 30%, 40%) were adsorbed onto $CaCO_3$, and the results show that the amount of HPAM adsorbed increases with increasing charge density. This phenomenon could be caused by the greater charge differences between HPAM and $CaCO_3$, thus causing greater attraction between the two which leads to increased adsorbed HPAM. In the crosslinking study, prior to adsorption analysis, HPAM was crosslinked with chromium (III) chloride solutions, ranging from 0.025 to 0.5wt% chromium, and investigated using simple shear rheology experiments to determine the optimum crosslinker mass fraction. Crosslinker concentration above 0.1wt% shows severe syneresis and reduction in polymer viscosity and was not investigated further. Adsorption study of HPAM crosslinked with 0.025wt% chromium (III) chloride solution shows a slight reduction in the amount of polymer adsorbed onto $CaCO_3$. This could be due to the formation of coordinate bonds between chromium (III) ions and carboxyl groups of HPAM. Lastly, the effect of functional group was studied by comparing the adsorption between 30% hydrolysed HPAM with 25% and 32% sulfonated polyacrylamide (SPAM) onto $CaCO_3$. Result shows that the equilibrium adsorbed amount of SPAM onto $CaCO_3$ is lower than 30% HPAM, which could be due to presence of the bulky sulfonate group which interferes with the surface packing, thus reducing the number of polymer molecules able to adsorb onto the surface. The equilibrium adsorbed amount of SPAM also slightly decreases with increasing sulfonation, which is likely to be due to the reduced attraction of the lower charge density polymer to the calcite.

Jin Hau Lew (*sl1420@ic.ac.uk*), is currently a PhD Chemical Engineering student from Imperial College London. Prior to his PhD pursuit, he briefly worked as a research assistant in PETRONAS Research Sdn Bhd (PRSB) where his research was in loose sandstone agglomeration through the application of polyacrylamide. His current research interest is the extension of his work from PRSB, which is currently on the strengthening of calcium carbonate formation through the application of polyacrylamide.

Désirée Martin: Emulsions stabilised with pectin-based microgels: Investigations into the effect of pH and microgel particle concentrations on emulsion stability

Gabriela I. Saavedra Isusi[1], Miriam Weilandt[1], Ildi Majollari[1], Désirée Martin[1], Heike P. Karbstein[1], Ulrike S. van der Schaaf[1]
1) Institute of Process Engineering in Life Sciences – Chair of Food Process Engineering, Karlsruhe Institute of Technology, Karlsruhe, Germany



Emulsion-based food products, such as drinks, salad dressings, desserts, and sauces, are part of our daily lives. These products are composed of two immiscible liquids (oil and water), and are thermodynamically unstable, thus, they require the use of emulsifying and often thickening agents in order to guarantee stability, and avoid phase separation (McClements, 2016). There is a wide range of emulsifying agents useful for this purpose, such as proteins and hydrocolloids, but also particles and low molecular weight surfactants. This contribution draws focus to a relatively new kind of emulsifying agents: Microgel particles (MGPs) based on biopolymers for food applications. Microgel particles are lyophilic, particulate polymer networks, whose properties are more complex than those of single polymer chains and particles.

Based on polyelectrolytes, pectin-based MGPs are assumed to be pH and ionic strength sensitive, in a similar manner to MGPs of synthetic polymers (Ngai, Behrens, & Auweter, 2005). Besides building a barrier around the oil droplets, charged MGPs repulse each other. Thus, the stabilisation mechanisms of pectin-based MGP should be both steric and electrostatic.

To investigate this, emulsions were homogenised with MGP concentrations ranging from 0.5 to 2 wt% MGP. After emulsification, the pH of the emulsions was adjusted to 4, 3, or 2; and the resulting droplet sizes were measured. We found out that the droplet size and the appearance of agglomerates increased with decreasing pH values. It was found that both a change in pH and an increase in ionic strength led to destabilization of the emulsions, with very rapid phase separation in the case of high ionic strengths and at pH < pKa. These results help understand the emulsion stabilisation mechanisms of pectin-based MGP and the effects of formulation parameters on the long-term stability of MGP-stabilised emulsions (Saavedra Isusi, Weilandt, Majollari, Karbstein, & van der Schaaf, 2021)

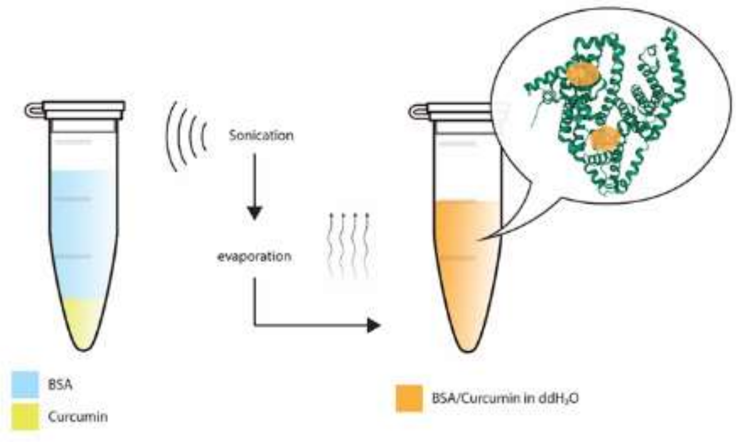
References:

[1] McClements, D. J., 2016, *Food Emulsions Principles, Practices, and Techniques*, CRC Press, Boca Raton, 3rd edn, ISBN 9781498726689
[2] Ngai, T., Behrens, S. H., & Auweter, H., Novel emulsions stabilized by pH and temperature sensitive microgels, *Chem. Commun.* 3 331–333 (2005) DOI: 10.1039/b412330a
[3] Saavedra Isusi, G. I., Weilandt, M., Majollari, I., Karbstein, H. P., & van der Schaaf, U. S., Emulsions stabilised with pectin-based microgels: investigations into the effect of pH and ionic strength on emulsion stability, *Food and Function* 12 7227-7238 (2021) DOI: 10.1039/d1fo00891a

Désirée Martin *(desiree.martin@kit.edu)* is working as a PhD student in the research group " Interfacial properties of pectin-based biopolymers" at the Karlsruhe Institut of Technology since 2021. She has been involved in industry-academic collaborative projects; for example, the modulation of organoleptic properties of vegan yogurt alternatives using a pectin-based structuring approach. In addition to vegan yogurt alternatives, she is researching the use of gummi arabicum in food emulsions. In her free time she enjoys hiking and meeting friends.

Konstantina Matskou: Inducing the formation of a colloidal albumin carrier of curcumin

Konstantina Matskou[1,2], Berke Kisaoglan[1], Barbara Mavroidi[3], Maria Pelecanou[3], Maria Zoumpanioti[1], Ilias Matis[1], Aristotelis Xenakis[1]
1) Institute of Chemical Biology, National Hellenic Research Foundation, Athens, Greece
2) Department of Biology, National Kapodistrian University of Athens, Athens, Greece
3) Institute of Biosciences and Applications, National Center for Scientific Research "Demokritos", Athens, Greece



The administration and delivery of pharmaceuticals faces a variety of well-known obstacles that result in limited biocompatibility and bioavailability. Efforts to improve these properties have often employed serum albumin, primarily due to its inherent biocompatibility and its ability to enhance the circulation times of pharmaceuticals [1]. In this work, we have adapted a nanoparticle formulation protocol, to produce a protein carrier of curcumin based on bovine serum albumin. This was achieved by using a near-equimolar protein:curcumin ratio instead of the abundance of curcumin that would be normally used in a nanoparticle formulation protocol [2]. Photometric and quantitative analysis of the carrier showed an increased curcumin content in the produced aqueous solutions following the homogenization of bovine serum albumin and curcumin phases. Albumin fluorescence studies indicated association with curcumin near a tryptophan residue, without excluding the possibility of additional sites. Circular dichroism provided strong evidence of this association and showed that the secondary structure of bovine serum albumin was effectively maintained. Overall, this work presents a new means of facilitating the association of increased levels of curcumin with bovine serum albumin, which could potentially be used to generate additional non-covalent albumin carriers for pharmaceutical compounds.

References:
[1] F. Kratz, Albumin as a drug carrier: Design of prodrugs, drug conjugates and nanoparticles, *J. Control. Release* 132 171–183.G. (2008)
[2] T.H. Kim, H.H. Jiang, Y.S. Youn, C.W. Park, K.K. Tak, S. Lee, H. Kim, S. Jon, X. Chen, K.C. Lee, Preparation and characterization of water-soluble albumin-bound curcumin nanoparticles with improved antitumor activity, *Int. J. Pharm.* 403 285–291 (2011)

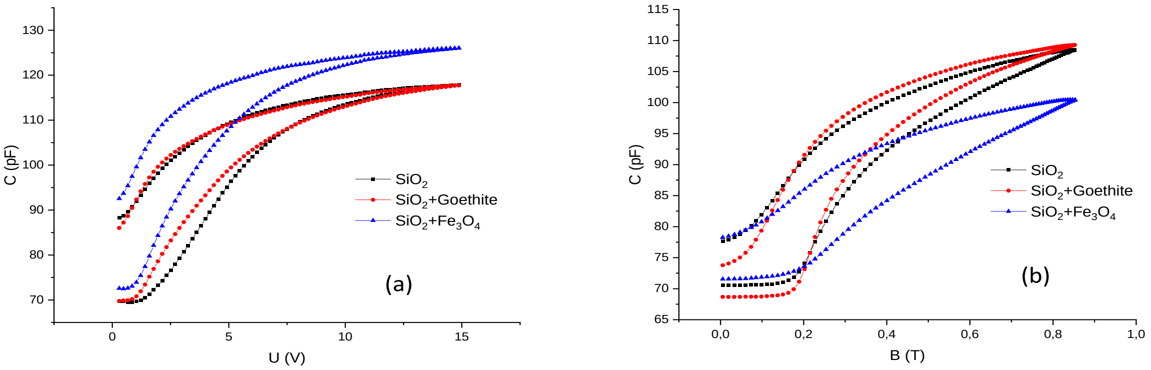
Matskou Konstantina (*kmatskou@eie.gr*) is a co-supervised PhD student in the Department of Biology, National and Kapodistrian University of Athens and the Biomimetics and Nanobiotechonology Lab of the institute of Chemical Biology, National Hellenic Research Foundation. She has been involved in academic-industry collaborative projects such as "CO$_2$ BioProducts" where she participated as a scientific collaborator for isolation of biomolecules from biomass, encapsulation and protection, antioxidant study of encapsulated biomolecules, protein nanoparticles. She has also studied polymeric, drug loaded scaffold construction via electrospinning process and her latest interest is focused on hydrogels for medical applications.

Dmytro Miakota: Memory effect in 5CB liquid crystal based composites

Dmytro Miakota, Katarína Zakutanská, Peter Kopcanský, Natália Tomašovicová
Institute of Experimental Physics of the Slovak Academy of Sciences, Košice, Slovak Republic.

Liquid crystals based composites have attracted a huge interest in fundamental and applied research communities by using them for electronic devices [1] where inorganic nanoparticles have a great potential due to a synergistic interaction with LCs [2]. Doping of liquid crystals with nanoparticles has been widely used, which makes it possible to change LCs physical properties. One of the manifestations of these changes was the presence of the memory effect in composites [3]. The memory effect, i. e. the increase in capacitance after applying voltage: the increasing voltage causes an increase in the capacitance, decreasing of voltage causes decreasing of capacitance, but in case of these composites a hysteresis is present and the final capacitance at $U = 0$ V is higher than the initial capacitance. The memory effect has been studied in a 5CB (4-cyano-4'-pentylbiphenyl) liquid crystal doped with non-magnetic SiO_2 nanoparticles [4]. It was found that even a small quantity of NPs has a strong influence on the memory effect. The explanation of the memory effect is that a weak network is created among the SiO_2 nanoparticles and the LC. By application of electric field composite changed its arrangement and follow the alignment of nematic domains. Moreover, the LC composite stays stabilized even after the electric field is turned off.

In this research the memory effect was explored in nematic phase of composites based on 5CB liquid crystal doped with spherical non-magnetic SiO_2 nanoparticles, magnetic spherical Fe_3O_4 nanoparticles and Goethite (α-FeOOH) nanorods. The prepared composites show a memory effect in nematic phase at ambient temperature (25 ^{O}C). This effect was explored in both electric (*a*) and magnetic (*b*) fields for all composites (figure). As a result, it revealed that the temperature erased the observed effect.

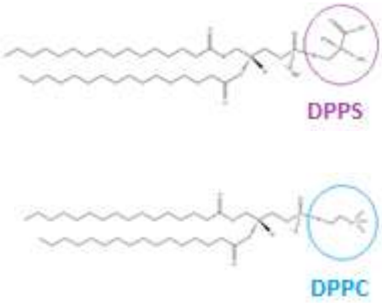


References:
[1] I. Muševic, S. žumer, Liquid crystals: maximizing memory, Nat. Mater. 10 266–268 (2011)
[2] Y. Zhang, Q. Liu, H. Mundoor, Y. Yuan, I.I. Smalyukh, Metal nanoparticle dispersion, alignment, and assembly in nematic liquid crystals for applications in switchable plasmonic color filters and E-polarizers, ACS Nano 9 (2015) 3097–3108.
[3] A.L. Rodarte, R.J. Pandolfi, S. Ghosh, L.S. Hirst, Quantum dot/liquid crystal composite materials: self-assembly driven by liquid crystal phase transition templating, J. Mater. Chem. C 1 5527–5532 (2013)
[4] Gdovinová, V., Tomašovičová, N., Jeng, S.-C., Zakutanská, K., Kula, P., Kopčanský, P. Memory effect in nematic phase of liquid crystal doped with magnetic and non-magnetic nanoparticles, Journal of Molecular Liquids, 282, pp. 286-291 (2019)

Dmytro Miakota (*miakota@saske.sk*) is a first year PhD student at the Institute of Experimental Physics of the Slovak Academy of Sciences (Department of Magnetism). He studied medical physics at the Faculty of Physics at Taras Shevchenko National University of Kyiv (2015-2021). Now his PhD thesis is related to liquid crystals and composites based on them.

Lea Pašalić: Impact of different cations on thermal properties of DPPS and DPPC lipid bilayers

Lea Pašalić[1], Danijela Bakarić[1]*
1) Division of Organic Chemistry and Biochemistry, Ruđer Bošković Institute, Bijenička 54, 10000 Zagreb



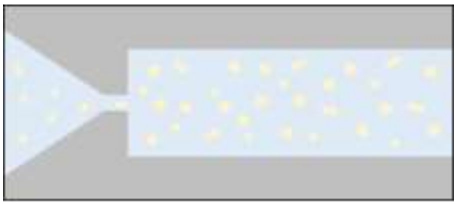
Phospholipid molecules present an essential part of biomembranes. Phosphatidylserine (PS) is the major anionic phospholipid present in eukaryotic membranes located on the cytosolic leaflet. One of its primary functions seems to be to impart a negative charge to the inner surface of the membrane lipid bilayer [1] which is required for the binding and activation of various peripheral membrane proteins [2]. The most abundant phospholipid in eukaryotic membranes, zwitterionic phosphatidylcholine (PC), can be distributed in both, inner and outer, membrane leaflets [3]. Lipid-constituted membranes undergo phase transitions, which in addition to temperature, pressure, and pH also depend on the chemical potentials of ions [4]. In this work we are focused on monitoring thermal properties of lipid bilayers constituted from 1,2-dipalmitoyl-*sn*-glycero-3-phosphatidylserine (DPPS) and 1,2-dipalmitoyl-*sn*-glycero-3-phosphatidylcholine (DPPC) in the presence of guanidinium (Gdm^+) and ammonium (NH_4^+) cations which is manifested in a change in melting temperature (T_m). Using FT-IR spectroscopy, UV-Vis spectrophotometry, and differential scanning calorimetry (DSC) our goal is to understand how these cations affects thermal properties of DPPS and DPPC lipid membranes. All experimental results are supported by the computational study.

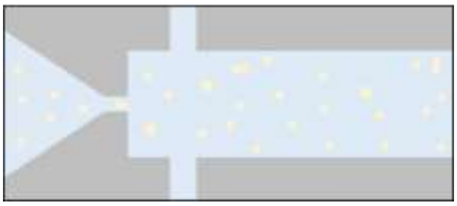
References:
[1] Ruthven N. A. H. Lewis, Ronald N. McElhaney, *Biophysical Journal* 79 2043–2055 (2000)
[2] A.G. Buckland, D. C. Wilton, *Biochem. Biophys. Acta.* 1483 199-216 (2000)
[3] M. Cebecauer, M. Amaro, P. Jurkiewicz, M.J. Sarmento, R. Šachl, L. Cwiklik, M. Hof, *Membrane* Lipid Nanodomains, *Chem. Rev.* 118 11259–11297 (2018)
[4] T. Heimburg, Thermal Biophysics of Membranes, First, Wiley-VCH Verlag GmbH & Co, Weinheim, 2007.

Lea Pašalić *(Lea.Pasalic@irb.hr)* studied Chemistry at Faculty of Science, Zagreb, and obtained master degree in Biochemistry and Analytical Chemistry. Currently, she works as research assistant in group of dr. Danijela Bakarić at Ruđer Bošković Institute, division of Organic Chemistry and Biochemistry. She enrolled doctoral studies in field of physical chemistry at Universiy of Science, Zagreb. During her research, she will investigate impact of peptides on the lipid domains using spectroscopic and calorimetric techniques.

Eva Rütten: Influence of mixing stream on droplet coalescence during emulsification in HPH process

Eva Rütten[1], Philipp Schochat[1], Luzie Allert[1], Heike P. Karbstein[1]
1) *Institute of Process Engineering in Life Sciences, Chair of Food Process Engineering, Karlsruhe Institute of Technology, Karlsruhe, Germany*





High-pressure homogenization (HPH) has a wide range of applications in the food and life science sectors for the production of emulsions. In this process, a pre-emulsion is generally compressed to high pressures and relaxed via a disruption unit. Typical disruption units are, for example, flat valves or orifices. Both geometries have in common that a very strong decrease of the flow cross-section accelerates the fluid flow. This results in very high local elongation and shear stresses, as well as cavitation and inertial forces. These lead to drop breakup downstream of the disruption unit. [1] Simultaneous emulsification and mixing (SEM) is an extension of the HPH process. Here, a mixing stream is fed into the turbulent zone downstream of the disruption unit. This allows the basic operations of emulsifying and mixing to be combined in a single step. Mixing the side stream in the SEM process has a considerable influence on the flow. Geometry as well as process parameters influence both the mixing and the droplet breakup. [2]

Drop break-up in the high-pressure homogenizer is - depending on the stock system and dispersion phase fraction - often a coalescence-dominated process. It is assumed that the coalescence rate can be reduced by the extended process. Experimental studies should also show the influence of the location of admixing and the ratio of the volume flows of high-pressure flow to mixing flow. The experimental data will be extended by simulation obtained flow data.

References:
[1] K. Köhler, F. Aguilar, A. Hensel, K. Schubert, H. Schubert, and H. P. Schuchmann. Design of a Microstructured System for Homogenization of Dairy Products with High Fat Content. *Chem. Eng. Technol.* 30 11 (2007)
[2] Karsten Köhler. *Simultanes Emulgieren und Mischen.* (2010)

Eva Rütten (*eva.ruetten@kit.edu*) is a PhD student at the Institute of Food Process Engineering and Life Sciences at the KIT in Karlsruhe. She is working on a project to study the flow-induced structural changes of proteins during cell disruption in a high-pressure homogenizer, which is funded by the German Research Foundation. Her PhD thesis deals with experimental and numerical investigation of flow in SEM orifices. Currently she is doing a research stay at the Department of Food Technology, Engineering and Nutrition at Lund University.

Meriem Saadli: Hybrid soft magnetic micro-actuators with thermo-programmable response to the external magnetic field

Meriem Saadli,[1] *Ahmed Mourran*[2] *and Jérôme Crassous*[1]
1) Institute of Physical Chemistry, RWTH Aachen, Aachen, Germany
2) DWI-Leibniz-Institute for Interactive Materials, Aachen, Germany

Hybrid materials that can respond to multiple stimuli are promising materials with the potential to be employed as carrier materials in biological systems [1]. Poly(N-isopropylacrylamide) PNIPAm hydrogels are an excellent option to achieve such systems. Their thermo-responsive nature allows a reversible switch from a swollen to a shrunken state. By adding maghemite nanoparticles and pre-programming their alignment in the matrix of those hydrogels, thermo- and magneto-responsive systems can be designed.

Different microgel shapes with embedded maghemites were synthesized using Particle Replication in non-wetting template (PRINT). Their thermo-and magneto- responsivities were determined through swelling experiments and by investigating their response under rotating magnetic fields of different strengths. These systems were characterized by a maximum rotation speed ω_c marking their transition from a synchronous to an asynchronous rotation. ω_c showed to be strongly varying with the temperature (Figure 1a).

When the hydrogels were additionally coated with a metal layer, the restricted swelling of the soft layer enabled the creation of more complex shapes [2-3]. The conformations and polarizability to the applied magnetic field of such shapes can be controlled with the temperature (Figure 1 b). These properties were further utilized to create diverse actuations combining the response to temperature, magnetic field, and light. Additionally, active micro-swimmers made from such a system can be designed and their swimming can be directed when an external magnetic field is applied [4].

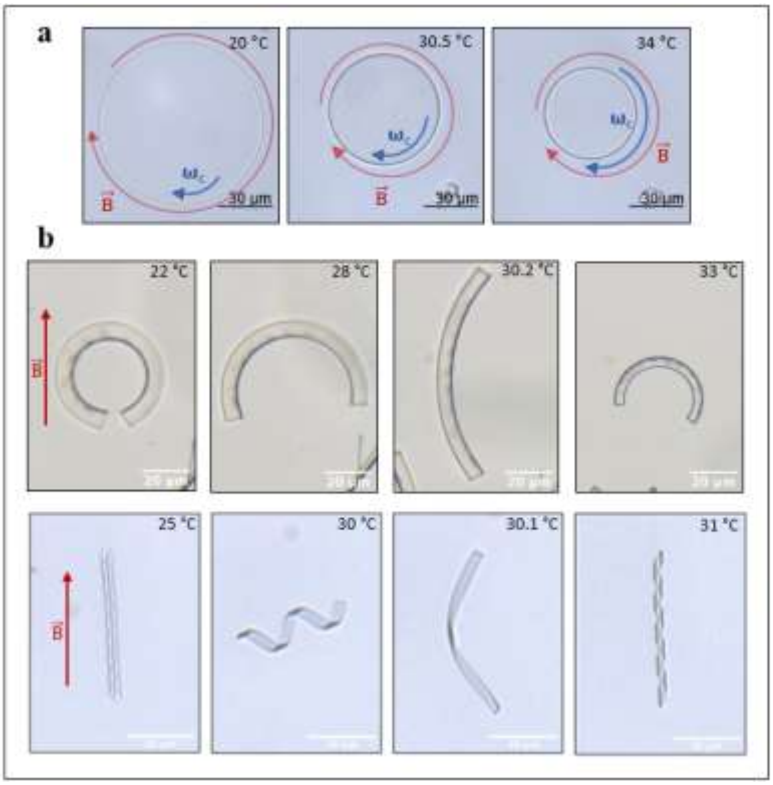


Figure 1. Thermo-responsive and magnetic microgels a) Hybrid disks with tunable response under an applied rotating field. b) Arc and helix bilayer structures that change their alignment to the field when the temperature is varied.

References:

[1] M. Vigata, C. Meinert, D. W. Hutmacher and N. Bock, *Pharmaceutics* 12 1188 (2020)
[2] H. Zhang, A. Mourran, and M. Möller, *Nano Lett.* 17 2010–2014 (2017)
[3] H. Zhang, L. Koens, E. Lauga, A. Mourran, and M. Möller, *Small* 15 1903379 (2019)
[4] A. Mourran, O. Jung, R. Vinokur and M. Möller, *Eur. Phys. J. E* 44:79. (2021)

Meriem Saadli (*saadli@pc.rwth-aachen.de*) is a Ph.D. candidate in the Physical Chemistry and Soft Matter research group from the Institute of Physical Chemistry of the RWTH Aachen University in Germany. Her doctoral work focuses on the fabrication and actuation of micro-composites made from a microgel matrix, particularly their response to the magnetic or the electric field when ferromagnetic or dielectric particles are introduced respectively. She holds a double bachelor's degree in chemistry with polymer chemistry as a major and a master's degree in chemistry with mesoscopic systems and catalysis as majors.

Kadosa Sajdik: Monitoring the effect of pH and ionic strength on the interaction between Bovine Serum albumin molecules and graphene oxide nanosheets

Kadosa Sajdik[1]*, Tamás Szabó*[1]
1) Colloid Layers Lab, Department of Physical Chemistry and Materials Science, Faculty of Science and Informatics, University of Szeged, Szeged, Hungary

Recently, the scientific interest of graphene-based materials has been impressive, especially in the medical and pharmaceutical fields. This is no coincidence, as these materials, such as graphene oxide, are promising for medical applications due to their physicochemical properties, such as large specific surface area. Because of this it has huge importance to understand fundamentally the interaction between graphene oxide (GO) and the biomolecules, such as serum albumins. To our surprise, only a few articles [1][2] are available in the literature that specifically explore the exact types of interactions between bovine serum albumin and graphene oxide in detail including the quantitative characterization. Therefore, at the basic research level, we would like to provide a comprehensive explanation of the interaction effects between BSA and GO. The most common methods employed previously were UV-Vis spectrophotometry in the UV range, Circular Dichroism, Scanning Electron Microscopy, Fluorescence Quenching. These techniques such as CD provide useful information but some other approaches may reveal additional structural characteristics. For example, we also used UV-Vis spectrometry, but using the less misleading Biuret test in the Vis range. We also performed XRD measurements for the analysis of the intercalation of BSA molecules between the GO lamellae, a method we have not seen yet in the literature we reviewed so far. We also measured the zeta potential of the BSA/GO composite. These measurements were carried out at several pH-s and ionic strength, so we monitored the adsorption properties of GO, the desorption processes of BSA from GO, the size of this composite and the occurring intercalation in different conditions. If we understand this interaction well, and are able to exploit it for the formulation of creams or ointments that exhibit prolonged release of the drug e.g. pain-relieving molecules on GO carriers.

Acknowledgements:
The project no. 124851 has been implemented with the support provided from the National Research, Development, and Innovation Fund of Hungary (NKFIH), financed under the FK funding scheme. We also thank the support from the ERA-NET COFUND /EJP COFUND Programme with co-funding from the EU Horizon 2020 programme and the NKFIH (project No. 2019-2.1.7-ERA-NET-2021-00029) in the frame of supporting the AtomDec Consortium by the Visegrad Group-Japan 2021 Joint Call on Advanced Materials. Support of the János Bolyai Research Scholarship from the Hungarian Academy of Sciences is also acknowledged.

References:

[1] H. Zhang, Changing the activities and structures of bovine serum albumin bound to graphene oxide, Appl. Surf. Sci.,427, 1019-1029 (2018).
[2] M. Šimšíková, Interaction of graphene oxide with albumins: Effect of size, pH, and T, Arch. Biochem. Biophys., 593, 69-79 (2016).

Kadosa Sajdik (*Sajdik.kadosa@outlook.hu*) is research associate at the Department of Physical Chemistry and Materials Science, Faculty of Science and Informatics, University of Szeged. He is a freshly graduated master student and is working on the topic to be presented since 2021 September. In his free time, he delights in preparing food colloids: brewing beer.

Krastina Stefanova: Effect of addition of glycerol on foamability and antifoam efficiency of low molecular mass surfactants

Krastina Stefanova, Vasil Georgiev, Zlatina Mitrinova, Slavka Tcholakova[1]
1) Department of chemical and pharmaceutical engineering, Faculty of Chemistry and Pharmacy, Sofia University "St. Kliment Ohridski", Sofia, Bulgaria

Glycerol is a component traditionally used to enhance the characteristics of different cosmetic products. The addition of glycerol in different surfactant solutions affects not only the viscosity of the media, but also the adsorption ability of the surfactants, which is why it can change their foamability and foam stability.

The major aims of the current study are to determine the effect of glycerol on: (1) Surfactant solubility, (2) Critical micelle concentration, (3) Mean area per molecule in the adsorption layer, (4) Adsorption kinetics, (5) Foamability and foam stability, (6) Antifoam activity of a mixed silicone-silica antifoam agent.

We analyzed the foaming properties of various surfactants: two nonionic – Brij 35 (polyoxyethylene-23 dodecyl ether) and Brij 58 (polyoxyethylene-20 hexadecyl ether), two anionic – SDS (sodium dodecyl sulfate) and SLES (sodium dodecyl ether sulfate with 1 etoxy group), and two cationic – CTAB (cetyltrimethylammonium bromide) and DTAB (dodecyltrimethylammonium bromide).

The results showed that the addition of glycerol leads to higher critical micelle concentration values, larger mean area per molecule, and lower adsorption rate. It is due to those shifts in the adsorption parameters, that the glycerol addition suppresses the foamability and improves antifoam activity.

The data for the foamability in presence of glycerol as a function of the surface coverage in the dynamic adsorption layers were compared with those, shown in the works of Petkova et al. [1,2], which are in absence of glycerol. The comparison showed that the universal dependences in [1,2] remain for foams, formed by glycerol containing media.

References:

[1] Petkova, B., Tcholakova, S., Chenkova, M., Golemanov, K., Denkov, N., Thorley, D., Stoyanov, S., Foamability of aqueous solutions: Role of surfactant type and concentration, *Adv. Colloid Interface Sci.* 276 102084 (2020)
[2] Petkova, B., Denkov, Tcholakova, S., Foamability of surfactant solutions: Interplay between adsorption and hydrodynamic conditions, *Colloids Surf. A* 626 127009 (2021)

Krastina Georgieva Stefanova (*kgs@lcpe.uni-sofia.bg*) is doing her BSc in "Chemical Engineering and Advanced Materials" in the Faculty of Chemistry and Pharmacy of Sofia University "St. Kliment Ohridski" in Sofia, Bulgaria. She has become a junior researcher in the Department of Chemical and Pharmaceutical Engineering, where she has learned techniques for studying thin liquid films, an important element in the characterization of soft matter systems such as foams, as well as several methods for characterization of the surface properties of surfactant solutions and for evaluation of the foam properties in the context of foam applications in several technologies.

Máté Sütő: pH-dependent removal of paracetamol from aqueous solutions by nanofiltration

Máté Sütő[1], Gábor Peintler[1], Tamás Szabó[1], Kadosa Sajdik[1]
1) Department of Physical Chemistry and Materials Science, University of Szeged, Rerrich Béla tér 1, H-6720 Szeged, Hungary

I investigated the nanofiltration of paracetamol from aqueous solutions, also known as acetaminophen and its pH dependence. As the use of acetaminophen is increasing rapidly nowadays its impact on the environment is also becoming more significant. In my experiments, paracetamol was removed from aqueous solutions by nanofiltration membranes with different pore sizes. During the filtrations, I used hydrochloric acid and sodium hydroxide to change the pH from acidic to alkaline and monitored the rate of retention. I found that between pH 3-7 the NF270 („loose nanofiltration") membrane produced a minimal retention of 4-8%, while between pH 7-9.5 the retention was 8-11% and then increased exponencially from pH 9.5 up to pH 11, at which I measured values around 50%. A similar effect was observed for the NF90 („tight nanofiltration") type membrane. Here I measured a retention of 75-77% in the pH range 7-9.5, while above that the amount of paracetamol removed increased sharply, almost to 100%. The pH dependence can be explained by considering the pKa (acidic dissociation constant) value of acetaminophen. The dissociation constant was determined experimentally at different salinities of the solutions (by titrimetry using pHcali software), and were used to correlate the the jump in retention found at slightly alkaline conditions.

Máté Sütő I am Máté Sütő, graduating BSc student of Chemistry from the University of Szeged. I am a member of the Junior Organizer Team and you may see some of my photographs at the website of the conference, including a city-prize-winning one showing Tyndall-effect in the „Liget" of Szeged. I am currently doing research in colloid chemistry focusing on membrane separation and I will soon be taking my final exam. My favourite photography subject is „brutal colloidal" or also known as storm photography. When the optical phenomena of nature's colloidal systems scare others away that's when I show up in the field!

Anna Katalin Vas: Graphite oxide/nickel ferrite nanocomposites for magnetic hyperthermia

Anna Katalin Vas,[1] Erzsébet Illés[2]
[1]Faculty of Science and Informatics, University of Szeged, Szeged, Hungary
[2]Department of Food Engineering, University of Szeged, Szeged, Hungary

Magnetic iron oxide nanoparticles (MNPs) are well-known for their great potential for biomedical use (for example drug-delivery, MRI contrast enhancement and hyperthermia), hence their possible diagnostic and therapeutic application has been the centre of many studies in the recent years. Beside magnetite, nickel-ferrite nanoparticles also seem to have promising magnetic properties for utilization in magnetic hypertermia. However, they require biocompatibilization with the application of a highly hydrophilic coating. Graphite oxide (GO) is a hydrophilic material, with high surface area and tuneable pH-dependent surface charge properties. By synthesizing GO/ MNP nanocomposites, it is possible to further enhance the heat production caused by an alternating magnetic field during hyperthermia sessions.

To study the effect of the nickel content and the various polymers used as protective layers on the surface of magnetic nanoparticles, nanocomposites were prepared with 1/5 and 1/10 GO/MNP mass ratios. The nickel content was 0%, 10% and 20%, while two different polymers (PAM and PEGMA-AA) were used to fully coat the nanomagnets. The dynamic light scattering (DLS) data on the coagulation kinetics of the various nanocomposite samples showed that there are notable differences in their colloidal stability. The critical coagulation concentrations were higher when PAM polymer was used and the nickel ratio also influenced the tolerance of the nanocomposites towards higher NaCl concentrations. Exposure for alternating magnetic field for 5 minutes showed that increasing the frequency (at the same magnetic field strength) results in a higher heat production. We are also planning to test hemocompatibility to evaluate the effects of the nanocomposites on blood components.

References:

[1] E. Illés, L. Nánai, Zs. Hegedűs, B. Müller and T. Szabó; Tunable Magnetic Hyperthermia Properties of Pristine and Mildly Reduced Graphene Oxide/Magnetite Nanocomposite Dispersions; *Nanomaterials* 10(12) 2426 (2020)

[2] Illés E., Szekeres M., Tóth Y. I., Farkas K., Földesi I., Szabó Á., Iván B., Tombácz E.; PEGylation of Superparamagnetic Iron Oxide Nanoparticles with Self-Organizing Polyacrylate-PEG Brushes for Contrast Enhancement in MRI Diagnosis; *Nanomaterials* 8 776 (2018)

Anna Katalin Vas is a first-year MSc student at the University of Szeged. She also received a bachelor's degree in chemistry from the University of Szeged. She has been involved in research projects about the potential biomedical application of iron oxide nanoparticles. She is interested in different areas of colloid chemistry and planning to continue her current research in the future.

List of Participants

Plenary speakers:

Prof Bandosz, Teresa J. (PL-3)
The City College of New York

Prof. Jedlovszky, Pál (PL-2)
Eszterházy Károly University

Prof. Lattuada, Marco (PL-1)
University of Fribourg

Prof. Vancsó, G. Julius (PL-6)
University of Twente

Prof. Vékás, Ladislau (PL-7)
Center for Fundamental and Advanced Technical Research Romanian Academy-Timisoara Branch

Prof. Vincent, Brian (PL-4)
University of Bristol

Prof. Warszyński, Piotr (PL-5)
Jerzy Haber Institute of Catalysis and Surface Chemistry PAS

Senior chairmen:

Szabó, Tamás
University of Szeged

Szilágyi, István
University of Szeged

Sponsors & exhibitors & other:

Heizer, Bálint
Anton Paar Hungary Kft.

Jóni, Viktor
Anton Paar Hungary Kft.

Kokavecz, László
Anton Paar Hungary Kft.

Paiva, Anderson (OP-9)
Anton Paar GmbH

Vajnai, Zsolt
UNICAM Magyarország Kft.

Students:

Abdul Hameed, Owais (PP-1)
University of Fribourg

Ali, Zeeshan (OP-20)
Norwegian University of Science and Technology

Alsharif, Nizar B. (OP-39)
University of Szeged

Argyri, Smaragda-Maria (OP-7)
Chalmers University of Technology

Bere, Katalin V. (OP-18)
University of Szeged

Beidrzycka, Adrianna (OP-31)
Maria Curie-Sklodowska University in Lublin

Bilén, Frida (OP-10)
Chalmers University of Technology

Borbás, Balázs (PP-2)
Budapest University of Technology and Economics

Borović, Teona Teodora (PP-3)
University of Novi Sad

Braunmiller, Dominik (OP-1)
RWTH Aachen University

Bulátkó, Anna (PP-4)
Budapest University of Technology and Economics

Chiriac, Alexandra M. (PP-5)
Babeș-Bolyai University

Debas, Meron (OP-16)
University of Fribourg

Demisli, Sotiria (OP-5)
Institute of Chemical Biology, National Hellenic Research Foundation;
University of Thessaly

Dorbic, Kata (OP-17)
University of Fribourg

Encheva, Mirela (OP-29)
University of Vienna

Eriksson, Viktor (OP-12)
Chalmers University of Technology

Fortes-Martín, Rebeca (OP-8)
University of Potsdam

Frigerio, Matteo (OP-30)
University of Fribourg

Fülöp, Dániel (PP-6)
Eötvös Loránd University

Galani, Eleni (OP-22)
Institute of Chemical Biology, National Hellenic Research Foundation;
Agricultural University of Athens

Gombár, Gyöngyi (OP-2)
University of Szeged

Gyenes, Péter (PP-7)
University of Szeged

Ion, Georgina (PP-8)
Babeș-Bolyai University

Kadakia, Parth (OP-6)
University of Fribourg

Kalbarczyk, Marta (OP-26)
Maria Curie-Sklodowska University in Lublin

Kása, Eszter (OP-28)
University of Szeged

Katana, Bojana (OP-32)
University of Szeged

Klačić, Tin (OP-25)
University of Zagreb

Kovács, Alexandra N. (OP-38)
University of Szeged

Krasińska-Krawet, Zofia (OP-36)
Jerzy Haber Institute of Catalysis and Surface Chemistry

Leister, Nico (OP-21)
Karlsruhe Institute of Technology

Lew, Jin Hau (PP-9)
Imperial College London

Martin, Désirée (PP-10)
Karlsruhe Institute of Technology

Márton, Péter (OP-37)
Budapest University of Technology and Economics

Massignan, Flavio (OP-14)
Eötvös Loránd University

Matskou, Konstantina (PP-11)
Institute of Chemical Biology, National Hellenic Research Foundation;
National Kapodistrian University of Athens

Mérai, László (OP-34)
University of Szeged

Miakota, Dmytro (PP-12)
Institute of Experimental Physics of the Slovak Academy of Sciences

Musicò, Angelo (OP-24)
University of Brescia;
CSGI, Research Center for Colloids and Nanoscience

Pašalić, Lea (PP-13)
Ruđer Bošković Institute

Péter, Nagy (OP-40)
University of Szeged

Russo, Giovanni (OP-15)
University of Fribourg

Rütten, Eva (P-14)
Karlsruhe Institute of Technology

Saadli, Meriem (PP-15)
RWTH Aachen University

Sajdik, Kadosa (PP-16)
University of Szeged

Samaniego Andrade, Samantha K. (OP-27)
Budapest University of Technology and Economics

Shiva Shankar, Lakhsmi (OP-11)
Research Centre for Natural Sciences, Budapest, Hungary

Shool, Lee (OP-23)
Bar-Ilan University

Skorzewska, Klaudia (OP-19)
L’Université de Montpellier

Stefanova, Krastina G. (PP-17)
University “St. Kliment Ohridski”

Sütő, Máté (PP-18)
University of Szeged

Szerlauth, Adél (OP-3)
University of Szeged

Takács, Dóra (OP-33)
University of Szeged

Tegze, Borbála (OP-13)
Budapest University of Technology and Economics

Turcsányi, Árpád (OP-4)
University of Szeged

Mrs. Varga Árok, Zsófia (OP-35)
University of Szeged

Vas, Anna Katalin (PP-19)
University of Szeged

June 26th / Sunday		June 27th / Monday		June 28th / Tuesday			June 29th / Wednesday			June 30th / Thursday	
		8:00-8:45	Registration								
		8:40-9:00	Opening								
			Biomedical aspects of colloids / Surfactants, micelles, self-assembly		*session 1 - Colloidal dispersions, foams, emulsions, suspensions*	*session 2 - Interfacial phenomena and adsorption*		*session 1 - Colloidal dispersions, foams, emulsions, suspensions*	*session 2 - Interfacial phenomena and adsorption*		*Polymer solutions, gels and phase behaviour*
		9:00-10:00	prof. Marco Lattuada	9:00-10:00	prof. Teresa J. Bandosz		9:00-10:00	prof. G. Julius Vancso		9:00-9:20	Zsófia V. Árok
		10:00-10:20	Dominik Braunmiller	10:00-10:20	Anderson Paiva		10:00-10:20	Giovanni Russo	Samantha K.S. Andrade	9:20-9:40	Zofia Krasińska-Krawet
		10:20-10:40	Gyöngyi Gombár	10:20-10:40	Frida Bilén		10:20-10:40	Debas Meron	Eszter Kása	9:40-10:00	Péter Márton
		10:40-11:00	Coffee break	10:40-11:00	Coffee break		10:40-11:00	Coffee break		10:00-10:20	Coffee break
		11:00-11:20	Adél Szerlauth				11:00-11:20	Kata Dorbic	Mirela Encheva	10:20-10:40	Alexandra N. Kovács
		11:20-11:40	Árpád Turcsányi	11:00-12:00	prof. Brian Vincent		11:20-11:40	Katalin V. Bere	Matteo Frigerio	10:40-11:00	Nizar B. Alsharif
		11:40-12:00	Sotiria Demisli				11:40-12:00	Klaudia Skorzewska	Adrianna Biedrzycka	11:00-11:20	Péter Nagy
		12:00-13:30	Lunch	12:00-13:30	Lunch		12:00-13:30	Lunch		11:20-11:50	Awards & Closing Ceremony
		13:30-14:30	prof. Pál Jedlovszky	13:30-14:30	prof. Piotr Warszyński		13:30-14:30	prof. Ladislau Vékás		11:50-13:20	Lunch
		14:30-15:30	Poster section & coffee break	14:30-14:50	Lakshmi S. Shankar	Lee Shool	14:30-14:50	Zeeshan Ali	Bojana Katana	13:20-14:30	Sightseeing
				14:50-15:10	Viktor Eriksson	Angelo Musicò	14:50-15:10	Nico Leister	Dóra Takács		
		15:30-15:50	Parth Kadakia				15:10-15:30	Eleni Galani	László Mérai		
		15:50-16:10	Smaragda-Maria Argyri	15:10-16:10	Poster section & coffee break		15:30-16:00	Coffee break			
17:00	Registration	16:10-16:30	Rebeca Fortes-Martín				16:00-16:45	//To Be Announced//			
18:00	Welcome reception			16:10-16:30	Borbála Tegze	Tin Klačić					
				16:30-16:50	Flavio Massignan	Marta Kalbarczyk	19:30-21:30	Conference dinner			

Final program of the 18th European Student Colloid Conference

26-30th June, 2022 Szeged, Hungary


NanoLab 3D


DWS RheoLab

RHEOMETER

The MCR rheometer series from the market leader offers you one thing first and foremost: an open range of possibilities. Whatever your rheological requirements are and will be in the future – based on its modular setup, your MCR rheometer is efficiently and comfortably adapted and extended to meet your needs, from routine quality control to high-end R&D applications. An investment in an MCR rheometer is always a safe investment in longstanding technology: The air-bearing-supported EC motor, for example, was developed by Anton Paar and has been used in all MCR models for over 25 years to ensure accuracy across a vast viscosity range. It makes it possible to measure liquids with a viscosity even lower than water and also characterize stiff materials like polymer composites or steel by DMA –and everything in-between.

Viscosity **(η)** vs. Shear rate **($\dot{\gamma}$)**

Viscosity **(η)** vs. Temperature **(T)**

Viscosity **(η)** vs. Time **(t)**

Viscosity **(η)** vs. Humidity **(rH)**

Viscosity **(η)** vs. Pressure **(p)**

Storage **(G')** and Loss modulus **(G'')** vs. Angular frequency **(ω)**

Storage **(G')** and Loss modulus **(G'')** vs. Temperature **(T)**

Storage **(G')** and Loss modulus **(G'')** vs. Time **(t)**

DYNAMIC LIGHT SCATTERING (DLS)

The Litesizer series is the perfect choice to characterize nano- and microparticles at the touch of a button. Particles in dispersion as well as peptides or macromolecules in solution can be determined over a broad concentration range, limiting the time for sample preparation. Litesizer 500 includes three measurement angles for particle size determination as well as patented cmPALS technology, which enables zeta potential measurements at low voltages with the highest repeatability and accuracy.

- Particle characterization from the nano- to the micrometer range (0.3 nm to 10 µm)
- Particle size measurements via dynamic light scattering at three different measurement angles
- Determination of zeta potential using patented cmPALS
- Molecular mass and refractive index measurements