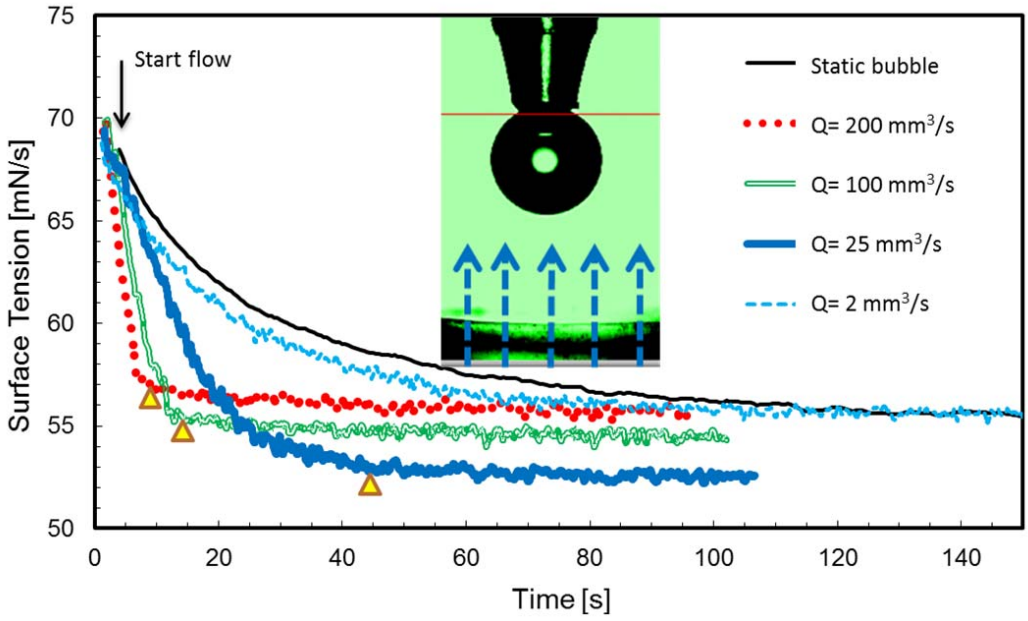
Report WG3 “Diagnostics” in COST action MP1106

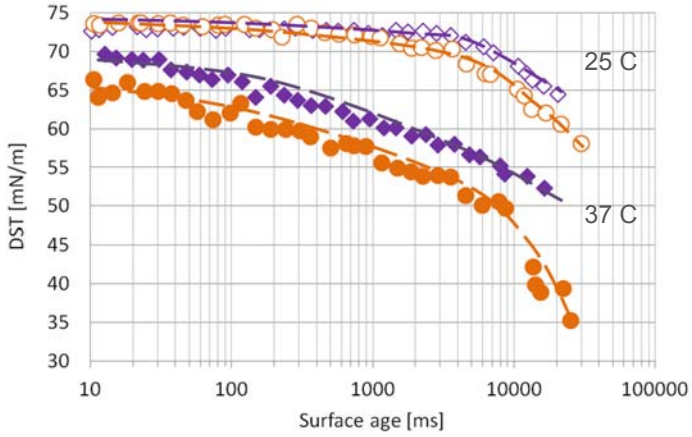
1. Highlights or breakthroughs in 2013

A new type of experiments was designed in the MPI group in Golm that mimics the situation of a bubble rising in a surfactant solution (*). By fixing the bubble at the tip of a capillary and positioning it into a liquid flow field, we get access to the capillary pressure in the bubble in real time. Similar experiments appear to be feasible also for drops in a flow field.



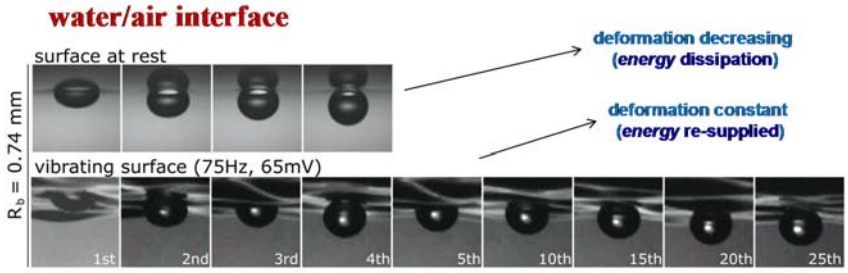
*M. Lotfi, D. Bastani, V. Ulaganathan, R. Miller and A. Javadi, Bubble in flow field: a new experimental protocol for investigating dynamic adsorption layers by using capillary pressure tensiometry, Colloids and Surfaces A, in press

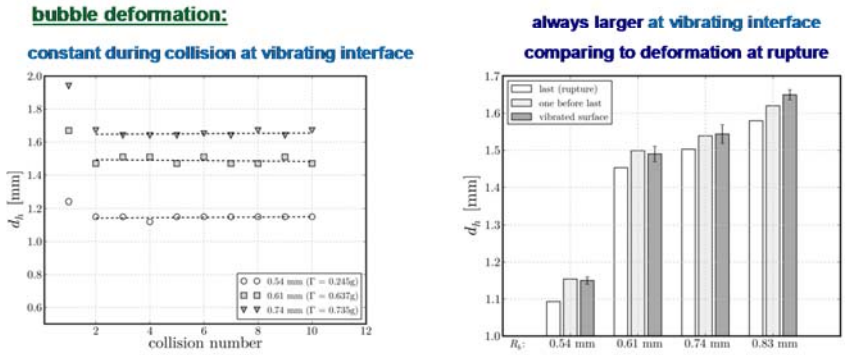
A maximum bubble pressure method was adapted at the Warsaw University of Technology to study the influence of nanoparticles and inhaled medicines on the surface activity of lung surfactant. The measurements has to be done in a system with reduced sample volume (7 ml) to enable studies with materials of limited availability.



An experimental proof of the hypothesis was provided by the group at PAN in Krakow that **if the kinetic energy, associated with the bubble motion, is re-supplied to the bubble colliding with**

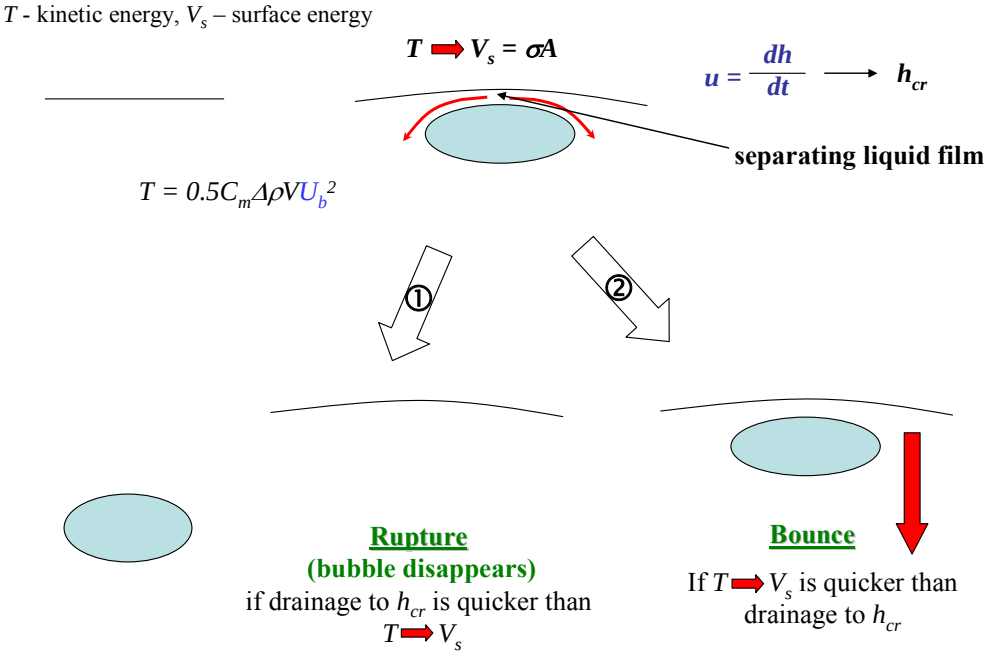
surface of ultra-pure water (devoid of any surface active substances) then the bubble bouncing can be prolonged indefinitely and the bubble did not rupture (*).
Energy was re-supplied by vibrations of water surface with definite frequency and amplitude.





It was also shown that the size of the liquid film formed by the colliding bubble is of crucial importance for outcome of the bubble collision with various interfaces

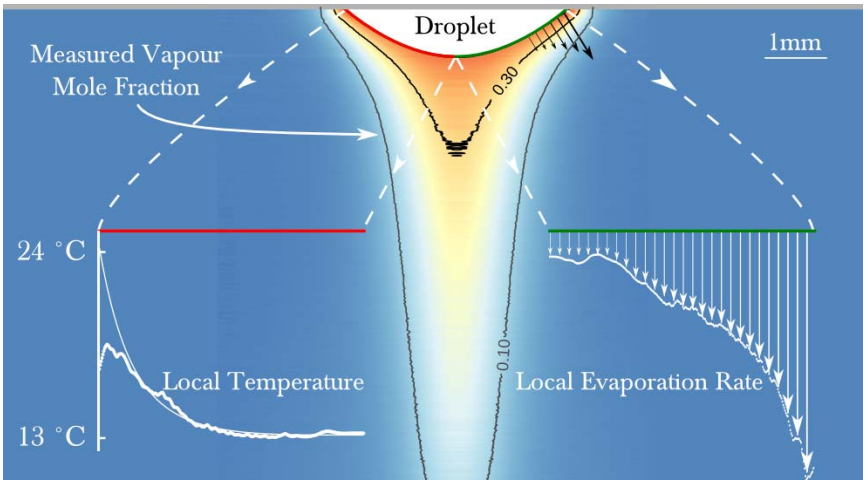
Mechanism of bubble bouncing and/or rupture during its collision with water/air interface



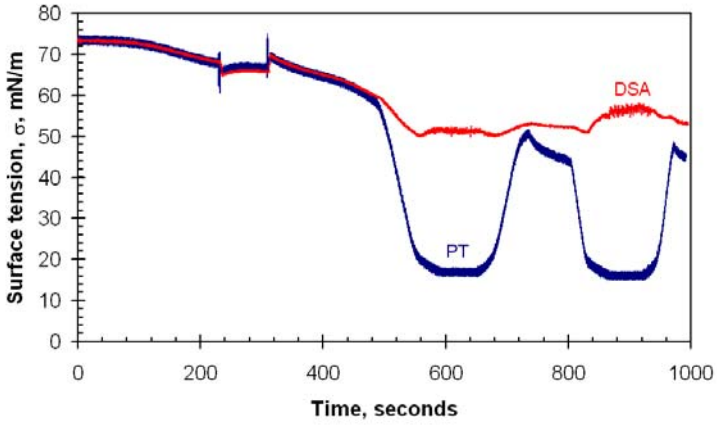
Bubble bounces when during the time of the collision the liquid film did not thin to its critical thickness of rupture

* J. Zawala, S. Dorbolo, N. Vandewalle, K. Malysa, "Bubble bouncing at clean water surface", Phys. Chem. Chem. Phys., 15 (2013) 17324

Using Digital Holographic Interferometry, the group of Pierre Colinet (Université Libre de Bruxelles, Bruxelles) was able to quantify the vapor mole fraction field surrounding an evaporating pending droplet. From this field, we were able for the first time to extract local evaporation rates and temperatures along the interface of the droplet as well as obtain an instantaneous global evaporation rate measurement. These results are published in: S. Dehaeck, A. Ye. Rednikov and P. Colinet, "Vapour-based interferometric measurement of local evaporation rate and interfacial temperature of evaporating droplets", Langmuir ***30***, 2002–2008 (2014); doi: 10.1021/la404999z.

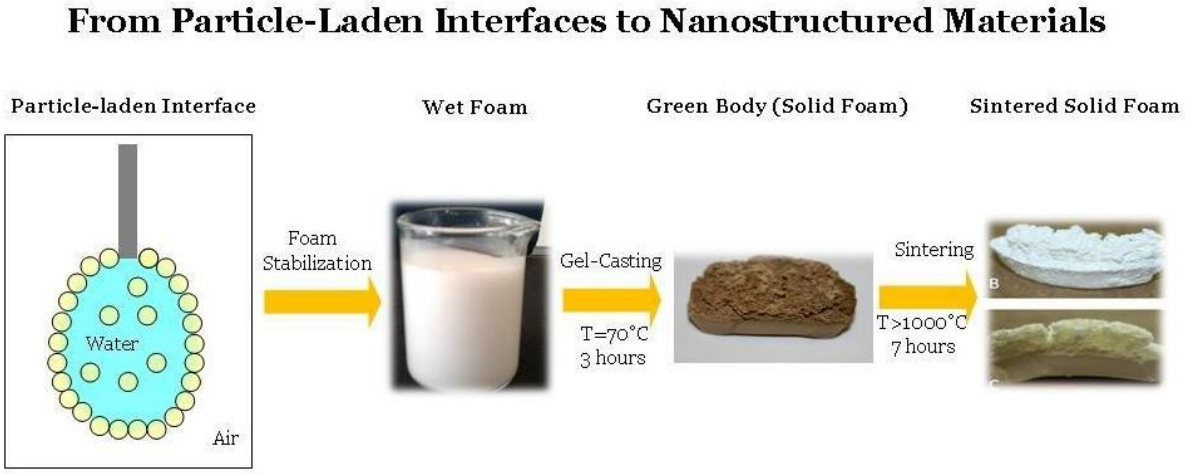


The pendant-drop method with drop-shape analysis (DSA) and capillary pressure tensiometry (PT) was applied by the group at the Sofia University to investigate the fluidity and surface dilatational rheology of adsorption layers. In contrast to the DSA, the CPT method detects a significant membrane pressure decrease, similarly to the measurements with a Langmuir trough. The applicability of the methods and the sources of errors are analysed and compared. The results are especially important for the many new applications involving highly elastic adsorption layers by solid particles, lipids, polymers, etc.



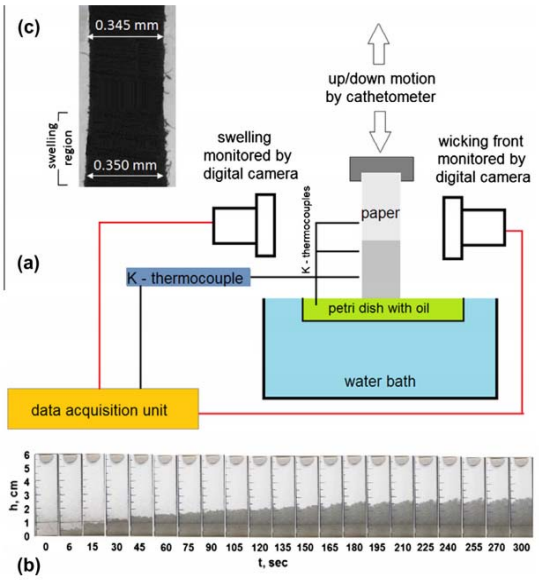
The groups of University Paris Sud and University of Brussels worked successfully on the modelling of the entrainment of liquid films by plates (Landau-Levich problem) or open frames (Frankel problem) in the presence of surfactants. The comparison with experiments has shown that the critical surface tension gradients to evolve from a regime with immobile surfaces to a regime with mobile surfaces are the same and are unexpectedly very small. A paper has just been submitted

The group at the CNR in Genoa developed procedures and protocols to obtain microporous ceramic and carbonaceous materials from particle-stabilised foams. Correlations between the interfacial properties of the precursors liquids (water+particles+surfactants+additives) and specific morphological features of the material have been derived (*).

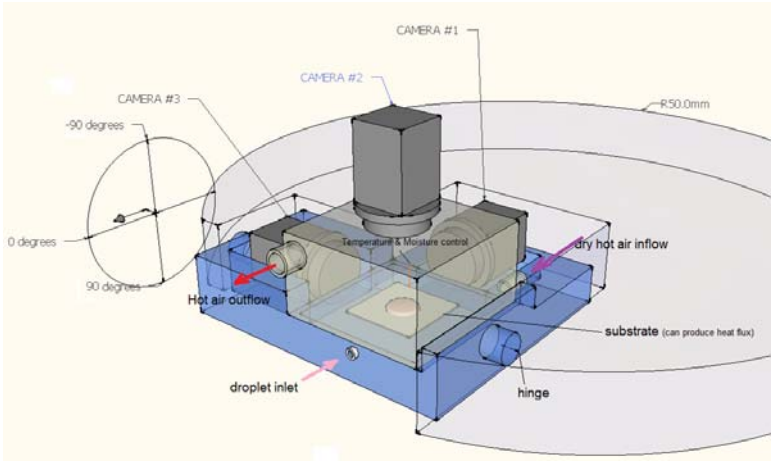


** D. Zabiegaj, et al. Colloids and Surfaces A: Physicochem. Eng. Aspects 438 (2013) 132– 140*

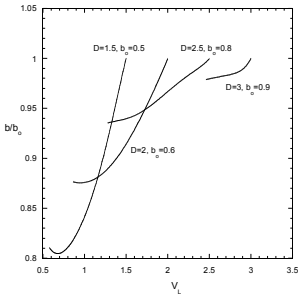
The work of the University of Thessaloniki provides experimental evidence that wicking speed (penetration rate of oil/gas interface) of oil into porous paper can be used as an effective rapid test to safely and easily distinguish fresh from prolonged fried oil.

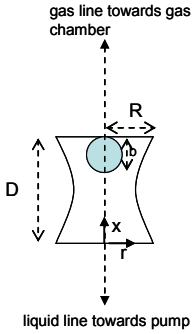


Also a novel centrifugal technique for studying droplet's contact line motion dynamics on solid substrates under the influence of varying body forces was proposed by the group at the University of Thessaloniki. The device is designed and preliminary tests are performed on droplet spreading over solid substrates made of different materials. Technical issues are dealt with regarding optical imaging and rotation speed.



The University of Thessaloniki *in addition provided an a***nalysis of a bubble-in-liquid bridge configuration as prototype for studying foam dynamics. I**n the context of developing a devise for the assessment of foam stability based on the liquid bridge-bubble configuration, a complete theoretical analysis for the system bridge-bubble in the absence of gravity is presented.





The group at BAN in Sofia was established that nanoassemblies of four-antennary oligoglycines can be used as captive agents for endotoxins (LPS) in aqueous systems (see A. Y. Gyurova, S. V. Stoyanov, E. Mileva, Interaction of four-antennary oligoglycines and lipopolysaccharides in aqueous media, Colloids Surfaces A, **2014**, in press).

2. new submitted national or EU projects on the topic of this cost action

- A project HARMONIA 5 was obtained by the Warsaw University of Technology in the framework of the research program of National Science Center (NCN - Poland).
- A new national project was submitted by the PAN group in Krakow and received funding:
- “Mechanism and kinetics of a bubble coalescence at undisturbed and vibrating with controlled frequency liquid/gas interfaces” for the period 2014-2017 - J. Zawala (Head of the project)
- The group of Novy Sad run a project on Dynamics of high-frequency drop formation with Agfa in Belgium
- Joined Erasmus application of Elena Mileva (BAN Sofia) and Marcel Krzan, Kazimierz Malysa (PAN Krakow).

3. examples of cooperation with teams of this COST action

- MPI in Potsdam performed rising bubble experiments with the group of K. Malysa in Krakow and on emulsion stabilization experiments with the group of R. Orr in Porsgrunn.
- The group of T. Sosnowski from Warsaw University of Technology made a common application for HARMONIA 5 project (nanoparticles-lung surfactant interactions) together with the group of Francesca Ravera at CNR Genoa.
- Bubble bouncing experiments are performed by the groups of K. Malysa (PAN Krakow) and N. Vandewalle and S. Dorbolo in Liege.
- Collaboration of P. Colinet (Uni Brussels) with Profs Catherine Colin and Dominique Legendre (IMFT - Toulouse) about the numerical modeling of boiling bubble growth and the influence of a dissolved component and temperature gradient in the liquid (generating a significant Marangoni effect).
- The University of Sofia (K. Marinova) organized cooperation with Unilever and the company Kruess.
- The University Paris Sud performed together with IPF in Paris an experimental study of surfactant-enhanced alkaline/diluted heavy oil systems. We identified a surfactant able to reducing the interfacial tension to ultra-low values and potentially interesting for enhanced oil recovery purposes. This surfactant enhances transport of polar substances present in the oil towards water. Measurements of pH in suitable conditions allow quantifying this transport. Two patents on the topic have been deposited.
- Collaborations of CNR in Genoa is running with the MPI-Golm, Univ. Tessaloniki and Univ. Aix-Marseille in microgravity-related experiments for emulsions and droplet interfaces.
- The group of CNR in Genoa has also collarboration with G. Cristofolini (Dept. Physics - Univ. Parma-Italy) on dynamic properties of particle-laden surface layers.

4. list of publications with acknowledgement to COST

1. D. Zabiegaj, E. Santini, E. Guzmán, M. Ferrari, L. Liggieri,V. Buscaglia, M. T. Buscaglia, G. Battilana, F. Ravera. Nanoparticle laden interfacial layers and application to foams and solid foams, Colloids Surfaces A: Physicochem. Eng. Aspects 438 (2013) 132– 140
2. A. Javadi, J. Krägel, M. Karbaschi, J.Y. Won, A. Dan, G. Gochev, A.V. Makievski, G. Loglio, L. Liggieri, F. Ravera, N.M. Kovalchuk, M. Lotfi, V. Ulaganathan, V.I. Kovalchuk and R. Miller, Capillary pressure experiments with single drops, in “Progress in Colloid Interface Science”, Vol. 4, P. Kralchevsky, R. Miller and F. Ravera (Eds.), 2013, 271-312.
3. E. Guzman, E. Santini, L. Liggieri, F. Ravera, G. Loglio J. Krägel, A. Maestro, R.G. Rubio, D. Grigoriev and R. Miller, Particle-surfactant interaction at liquid interfaces, in “Progress in Colloid Interface Science”, Vol. 4, P. Kralchevsky, R. Miller and F. Ravera (Eds.), 2013, 77-109.
4. A. Javadi, N. Mucic, M. Karbaschi, J.Y. Won, M. Lotfi, A. Dan, V. Ulaganathan, G. Gochev, A.V. Makievski, V.I. Kovalchuk, N.M. Kovalchuk, J. Krägel and R. Miller, Characterization methods for liquid interfacial layers, Eur. Phys. J. Special Topics 222 (2013) 7–29.
5. A. Dan, R. Wüstneck, J. Krägel, E.V. Aksenenko, V.B. Fainerman and R. Miller, Adsorption and Dilational Rheology of Mixed β-Casein/DoTAB Layers Formed by Sequential and Simultaneous Adsorption at the Water/Hexane Interface, Langmuir, 29 (2013) 2233–2241.
6. A. Dan, R. Wüstneck, J. Krägel, E.V. Aksenenko, V.B. Fainerman and R. Miller, Adsorption and Dilational Rheology of Mixed β-Casein/DoTAB Layers Formed by Sequential and Simultaneous Adsorption at the Water/Hexane Interface, Langmuir, 29 (2013) 2233–2241.
7. A. Dan, G. Gochev, J. Krägel, E.V. Aksenenko, V.B. Fainerman and R. Miller, Interfacial rheology of mixed layers of food proteins and surfactants, COCIS, 18 (2013) 302–310
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9. V.B. Fainerman, N. Mucic, V. Pradines, E.V. Aksenenko and R. Miller, Adsorption of alkyltrimethylammonium bromides at water/alkane interfaces – competitive adsorption of alkanes and surfactants, Langmuir, 29 (2013) 783–789.
10. Sosnowski T.R. Nanosized and nanostructured particles in pulmonary drug delivery. J. Nanosci. Nanotechnol. – accepted (full paper – invited review)
11. Sosnowski T.R., Kurowska A., Butruk B. Jabłczyńska K. (2013). Spraying of cell colloids in medical atomizers, AIDIC Conference Series 11, 371-380. (full paper - DOI:10.3303/ACOS1311038)

12. Sosnowski T.R., Kurowska A., Butruk B. Jabłczyńska K. (2013). Spraying of cell colloids in medical atomizers, Chem. Eng. Transact. 32, 2013, 2257-2262. (full paper - DOI: 10.3303/CET332377)
13. Sosnowski T.R., Kurowska A., Butruk B. (2013). Atomization of living cells from aqueous suspensions, J. Aerosol Med Pulm. Drug. Del. 26(2), A40-A41 (abstract)
14. Sosnowski T.R., Jabłczyńska K. (2013). Aerosol droplet size in the pulsed jet nebulization, J. Aerosol Med Pulm. Drug. Del. 26(2), 2013, A41 (abstract)
15. Kramek-Romanowska K., Sosnowski T.R. (2013). Dynamic interactions of selected mineral nanoparticles with the pulmonary surfactant at the air/water interface. Abstracts of COST MP1106 Annual Meeting, Prague, 21-22.03.2013. p. 60 (abstract)
16. J. Zawala, S. Dorbolo, N. Vandewalle, K. Malysa, “Bubble bouncing at clean water surface”, Phys. Chem. Chem. Phys., 15 (2013) 17324
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18. D. Kosior, J. Zawala, R. Todorov, D. Exerowa, K. Malysa, „Bubble bouncing and stability of liquid films formed under dynamic and static conditions from n-octanol solutions”, Colloids & Surfaces A:, http://dx.doi.org/10.1016/j.colsurfa.2013.11.022
19. J. Zawala, D. Kosior, K. Malysa, ” Air-assisted bubble immobilization at hydrophilic porous surface”, Surface Innovations, doi: 10.1680/si.13.00031
20. Wylock, S. Dehaeck, D.A. Quintans, P. Colinet and B. Haut, “CO_2 absorption in aqueous solutions of N-(2-hydroxyethyl)piperazine: experimental characterization using interferometry and modeling”, Chem. Eng. Sci. 100, 249-258 (2013); doi: 10.1016/j.ces.2013.02.068.
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25. Dimi Arabadzhieva, Plamen Tchoukov, Borislav Soklev, Elena Mileva, Interfacial layer properties and foam film drainage kinetics of aqueous solutions of hexadecyltrimethylammonium chloride, Colloids and Surfaces A, 2014, accepted.
26. A. Y. Gyurova, S. V. Stoyanov, E. Mileva, Interaction of four-antennary oligoglycines and lipopolysaccharides in aqueous media, Colloids and Surfaces A, 2014, in press.
27. Terziyski I., Alexandrova L., Stoineva I., Christova N., Todorov R., Cohen R., Foam and wetting films from rhamnolipids produced by Pseudomonas aeruginosa BN10, Colloids and Surfaces A, 2013, (in press)DOI:10.1016/j.colsurfa.2013.12.075
28. Hristina Petkova, Khristo Khristov, Dochi Exerowa, Critical capillary pressure: a parameter for evaluation thinliquid film stability, Comptes Rendus de L'Academie Bulgare des Sciences, 2014, in press

5. joint STSM within this COST action

Stay of M. Karbaschi (MPI in Potsdam) in the labs of R. Orr (Statoil in Porsgrunn).
Stay of Antonio Perazzo (Uni Naples) in the labs of MPI in Potsdam.
Stay of M. Krzan (PAN in Krakow) in the labs in Univ. Liege.