Speaker: Dr. Apostolos Vagias

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Title: “Basic aspects of neutron science and soft matter/ infrastructures at the Institute Laue Langevin (ILL) - Polymer compatibility on mixed brushes probed by high pressure GISANS (HP-GISANS) and reflectivity”

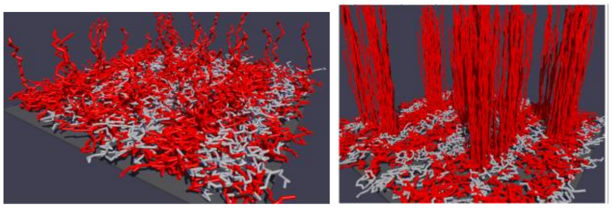
In the first part of my talk, I will cover basic aspects about neutron scattering for soft matter systems. I will then present an overview of the Large Scale Structures Group at the Institute Laue - Langevin (ILL). In the second part, I will focus on my own research background concerning supported soft matter using neutron methods under ambient and extreme conditions (high hydrostatic pressure and temperature).

Background: The elucidation of material nanostructure under elevated pressures is quite relevant for devices used in deep sea research, including tactile sensors and soft robotics [1]. To accommodate resistance to harsh underwater environments, multicomponent systems need to be utilized with orthogonal properties. Technical challenges had so far hampered the investigation of thin film nanostructures of varying compositional complexity under elevated hydrostatic pressures.

Methods: By utilizing a custom-made pressure cell [2] and performing Grazing Incidence Small Angle Neutron Scattering under pressure (HP - GISANS) at D22 and neutron reflectometry (NR) at FIGARO instruments of the ILL [3,4], I compare effects of pressure and temperature at the solid-liquid interface between two homopolymer mixed brushes in thin (< 100 nm) film using D2O solvent: A weakly incompatible (poly(methyl methacrylate) / poly(2-(dimethylamino)ethyl methacrylate)) (PMMA / PDMAEMA) and strongly incompatible ((poly((2,2,3,3,4,4,5,5-octafluoro)pentyl methacrylate))/ poly(2-(dimethylamino)ethyl methacrylate)) (POFPMA/PDMAEMA) mixed brush.

Results: Distinct pressure-dependent response in lateral (HP - GISANS) and transversal (specular NR) nanostructure is recorded depending on the chemical compatibility between the polymers. GISANS simulations indicate buried hydrophobic dimple-like patches within a PDMAEMA-based swollen matrix. Specular ToF-NR suggests that temperature effects are counteracted by pressure. Off-specular NR reveals large (>100 nm) lateral domains associated to the hydrophilic PDMAEMA compound, being both pressure-dependent and polymer-compatibility dependent.

Conclusion: Length scale of phase separation strongly depends on the compositional variation in the flat mixed brushes. Also, non-idealities of mixing are polymer-compatibility dependent as evidenced by enhanced D_2O retention within the brush by the more strongly incompatible POFPMA/PDMAEMA.



Graphic representation [4] for the “as-conceived” morphologies of the strongly incompatible POFPMA/PDMAEMA at T = 45 ℃ for (a) P = 1 bar and (b) P = 800 bar. Grey represents the POFPMA chains and associated POFPMA-related surface micelles, red stands for the PDMAEMA chains and PDMAEMA-based domains.

[1] Li G., et al., *Nature Communications* (2023) **14**, 7097 ;
[2] Kreuzer, M., et al., *Rev. Sci. Instr.* (2011) **82**, 023902 ; [3] Vagias A. et al., *J. Appl. Cryst.* (2024) **57**, 1978-198 ; [4] Vagias A. et al., (submitted)