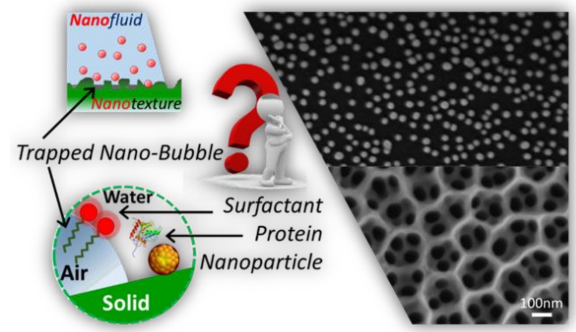
Functional plasma polymers for biosensing applications

Materials with intricate nanostructures display wetting properties that modern technologies already use to lubricate engines or waterproof clothing. Yet, their full potential in applications for sustainable catalysis, air purification or biosensing cannot be realised until we understand how nano-objects adsorb to surfaces with features of comparable size. Indeed, controlling or even predicting how proteins, antibodies, exosomes, surfactant or nanoparticles stick to nano-engineered surfaces is a challenge because key aspects of the wetting phenomenon remain poorly understood at this scale. In this talk, I will briefly review what we currently know about "nanowetting".[1] I will then introduce the concept of plasma polymerisation as a technique to control both surface chemistry and surface topography. I'll use the example of plasma deposited polyoxazoline (POx) to highlight this technique's attributes, drawbacks and recent progress made in understanding the unique chemistry and reactivity of POx films, using both plasma in-situ and post deposition spectroscopic analysis.[2] Plasma deposited Polyoxazoline thin films share many valuable properties with polyoxazoline prepared via conventional organic chemistry: they are biocompatible, non-cytotoxic and low fouling.[3] What is more, they bind biomolecules covalently, support cell adhesion, and are generated in a solvent free, single step process, which makes them particularly attractive for industrialization. For these reasons, plasma deposited polyoxazoline are used in applied biomedical research, from in vitro stem cell culture to controlling immune responses.[4]



I'll conclude this presentation with tangible outcomes of the translational research projects I've conducted with various industries, where we used nanoengineered plasma polymers, to create materials for cancer diagnosis and growing organoids.[5]

[1] **M. MacGregor** and K. Vasilev. *Advanced Materials Interfaces, 4*, 1700381., 2017**;** **M. MacGregor** et al., *Nanoscale*, 8(8),4635-4642, 2016

[2] **M. Macgregor*** et al. *Chemistry of Materials, 29(19)8047-51,* 2017; **M. N. MacGregor**-Ramiasa et al., *J. Mat. Chem. B*, 3, 6327-6337, 2015

[3] **M. N. Ramiasa** et al. *Chem. Commun.*, 51, 4279-4282, 2015**;** A. A. Cavallaro, **M. N. Macgregor**-Ramiasa, K. Vasilev, *ACS Appl. Mater. Interfaces 8*, 6354, 2016.

[4] R. M. Visalakshan, A. A. Cavallaro, **M. N. MacGregor**, et al. *Adv. Funct. Mat.*, 29, 1807453, 2019**;**

[5] **M. MacGregor*** et al. *Biosensors and Bioelectronics,* 171: 112699,2020; K.M. Chan […]**M. MacGregor*** *Cancers* 13(21), 5544 2021

Biography

A/Prof Melanie Macgregor is an ARC Future Fellow at Flinders University, Institute for Nanoscale Science & Technology. She obtained a Master of Chemical Engineering in France before moving to Australia and completing her PhD in Material Engineering from UniSA in June 2013. In 2018 she received a Santos-UCL Fellowship and established her independent research group at the Future Industries Institute. She works on industry-driven translational research in close partnership with end users, clinicians, industry and academics from complimentary disciplines. Her applied research program includes multiple projects to develop novel advanced manufacturing solutions for the biomedical and energy industries. Specifically, she explores the effects of surface chemistry and nanoscale topography on the interaction between (bio)materials and their environment.

Melanie has, for instance, worked on developing bioengineered platforms capable to guide cell growth and differentiation, and selective cell capture devices for diagnostic purposes. In this field, she has led several externally, internally and industry funded projects as principal chief investigator (Channel 7 Children Research Foundation grant, UniSA Research Theme Investment Scheme project, New adventure fund Project). In 2017, her collaborative research work was further funded through a $6M CRC-P project in partnership with SMR automotive and Flinders Medical Centre, aiming to industrialise biomedical devices for the non invasive diagnosis of bladder cancer. In 2018, her fundamental work on wetting phenomena at the nanoscale was funded by an ARC discovery project in collaboration with QUT and the Max Plank Institute for Polymer research in Germany. It is this aspect of her research that Melanie is exploring in her ARC Future Fellowship. Her team works with (inter)national collaborators from UCL, ETH Zurich, INL Braga, and Curtin University to apply these findings to new technologies for heterogenous catalysis, and medical devices.

The quality of her research, innovation and science communication have been recognised through several awards, including the 2016 Engineers Australia John A. Brodie Medal for achievement in Chemical Engineering , the 2017 UniSA ITEE Early Career Researcher award, the 2017 Winnovation awards in the Engineering category, and a 2018 SA Young Tall Poppy Science Award. In 2019, she was selected to participate to the SuperStar Of STEM program hosted by Science Technology Australia. Melanie is currently on the SA committee of the AFRAN (Australian-French Association for Research and Innovation) and a national board member of the RACI (Royal Australian Chemical Institute).