Centre for **Sustainable** Chemical Technologies

MONASH University

UNIVERSITY OF BATH

Bath Monash Global PhD Programme in Sustainable Chemical Technologies

Project Title:	Advanced, Tuneable Encapsulates prepared from Biodegradable Polymers and Silica
Supervisor at Bath:	Professor Janet Scott
Supervisors at Monash:	Professor Bart Follink (lead) and Dr Rico Tabor
Home Institution:	Monash University
Indicative period at Host Institution:	12 months with exact dates to be confirmed

Project Summary

There is much current interest in the replacement of polymers that can be sources of microplastic pollution, in consumer goods. Microbeads made from polymers (usually fossil carbon derived) that are non-biodegradable have been banned in "rinse-off" products in many countries, including the UK[1] and recent developments in Europe[2] and elsewhere suggest that there will be further focus on sources of microplastics. Another potential source of microplastics in consumer goods are the shells of polymer encapsulated materials (encaps), including perfumes and active ingredients such as bleaches used in clothes wash products, thus, more sustainable alternatives for encaps would be desirable. The challenges are not insignificant, as these must be easy (and cheap!) to prepare in processes that are scalable for manufacturing, robust in formulation (not prone to degradation and not overly fragile), effective in delivery (e.g. adhering/not adhering to garments during washing depending on payload to be delivered), and amenable to breakage or bursting to deliver the payload at the correct time.

Follink *et al.*, have wide expertise in the formation of silica shells and core/shell particles[3] that are tuneable with regards to robustness and surface characteristics. Their capsules have been shown to be capable of being fine-tuned to be loaded with a range of payloads with controlable release characteristics. Moreover, through appropriate surface modification of the silica shell, these capsules can be targeted to selectively adhere to specific substrate chemistries. Scott *et al.*, have developed a series of biodegradable biopolymer supported emulsions and encaps,[4] but these can suffer from a lack of robustness (to drying, for example).

In this joint PhD project we propose to combine these technologies, bringing together the expertise at Monash and Bath universities to expand the range of encap shells that can be produced targeting reinforced and multi-layer shells. Further, as the Bath team have demonstrated the use of continuous membrane emulsification processes[5] to produce narrow particle size droplet distributions, such processes will be

1 For example, The Environmental Protection (Microbeads) (England) Regulations, 2017, available from http://www.legislation.gov.uk/uksi/2017/1312/contents/made

2 ECHA ANNEX XV RESTRICTION REPORT PROPOSAL FOR A RESTRICTION (intentionally added microplastics), 11 January 2019, available from https://echa.europa.eu/documents/10162/82cc5875-93ae-d7a9-5747-44c698dc19b6

3 Shane P Meaney, Bart Follink, Rico F Tabor, Synthesis, Characterization, and Applications of Polymer-Silica Core-Shell Microparticle Capsules, ACS Appl. Mater. Interfaces, 2018, 10, 43068-43079, and S P Meaney, R F Tabor, B Follink, Synthesis and Characterisation of Robust Emulsion-templated Silica Microcapsules, J. Colloid Interface Sci., 2017, 505, 664-672

4 Results not yet published

5 J. Coombs OBrien, L. Torrente-Murciano, D. Mattia, and J. L. Scott Continuous Production of Cellulose Microbeads via Membrane Emulsification, *ACS Sustainable Chem. Eng.*, 2017, **5**, 5931–5939.

incorporated into the project to demonstrate the “manufacturability” of the encaps and the Monash expertise in nano-indentation will be employed to test strength and robustness of structures formed, including under a range of conditions simulating use or release in response to stimuli (e.g. change of pH, temperature or humidity).