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Converting Nature's most abundant biopolymer into materials to substitute persistent, petrochemically derived polymers

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Abstract:

Cellulose is the most abundant biopolymer and is eminently renewable with estimates of 10^{11} - 10^{12} tonnes renewed annually. Much effort is expended in converting some of this resource into fuels and chemicals, but, instead of deconstructing the polymer at a molecular level we aver that there are significant opportunities to use the exquisite structure of cellulose to produce materials that could offer alternatives to fossil carbon derived polymers, particularly in applications where recovery and reuse/recycle are not straightforward.

Using chemistry and processes designed to be scaleable, we prepare cellulose based:

- Microbeads and microcapsules, with applications in consumer products – with potential to replace persistent plastic microbeads, which are often made of PE or PMMA);
- flame retardant composite films targeting use in electronics – where triggered degradation could offer opportunities for precious metal recovery, i.e. contributing to resource efficiency and offering opportunities for approaches consistent with the circular economy;
- metal scavenging materials – for recovery of precious metals from industrial wastes;
- hydrogel and film based scaffolds for tissue engineering – where the stability of dried cellulose materials could offer non-cold chain reliant materials;
- particulate rheology modifiers and Pickering emulsion stabilizers that are effective at low weight percent inclusion in aqueous (and other) formulations – to substitute synthetic polymer viscosity control agents and some surfactant; and
- paper-based printed microbial fuel cell sensor devices with non-metallic circuitry – geared towards enabling community based testing of contaminated water.

In all of these applications synthetic chemical modifications, which can be critical to generating specific properties, are applied in a targeted fashion, modifying only the parts of the material required for the application, e.g. surfaces and conductive inks. Processes are developed to be continuous or amenable to scaling-up and energy and resource considered.



Prof. Janet L. Scott (1964) completed her BSc degree at the University of Natal and Hons and PhD degrees at the University of Cape Town (UCT), 1995. She has worked in industry and academia: Lecturer, UCT (SA), R&D Manager Fine Chemicals Corp. (SA), Lecturer/Sen. Lecturer/Deputy Director, ARC Centre for Green Chemistry, Monash University (Australia), Senior Marie-Curie Transfer of Knowledge Fellow, Unilever (UK), and Director JLS ChemConsult Ltd. (UK). She is now the Professor of Sustainable Chemistry and the Training Director of the Centre for Doctoral Training in Sustainable Chemical



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