MESTECH Research Project

Project Title: Characterisation of Photocurable Sol-gel Materials for Microfluidic Applications

Project Researcher: Mary O'Sullivan

Funding Body: Beaufort Marine Awards Internship Programme

Project Summary: The goal of this work will be to correlate the chemical composition of some photocurable hybrid sol-gel materials to their surface properties. Hybrid sol-gel materials are synthesised in the liquid state, employing organic and inorganic chemical precursors. Over the past five years, the NCSR has successfully studied and developed novel photocurable formulations[1,2] which can be micropatterned by selective UV exposure. These materials have been applied to the development of optical waveguides (Fig. 1), sensors, and more recently for the fabrication of tri-dimensional structures (Fig. 2), employing the 2-photon polymerisation technique.
In this work we wish to extend the use of sol-gels into the domain of microfluidics. Microfluidics is the science of handling and manipulating small volumes of liquid in the micro-scale, and is attracting increasing interest for environmental and biomedical sensing applications. This is largely because microfluidics facilitates the automated sampling of an analyte without human intervention (e.g. sea or river water) and the reduced use of expensive sensing reagents. With careful selection of materials, the microfluidic channel can also fill without the use of pumps via capillary forces. Microfluidic channels are typically fabricated by injection moulding of plastics. However, the use of photocurable sol-gel materials permits the exploitation of high-volume, high accuracy fabrication techniques from the semiconductor industry – in this case, photolithography.

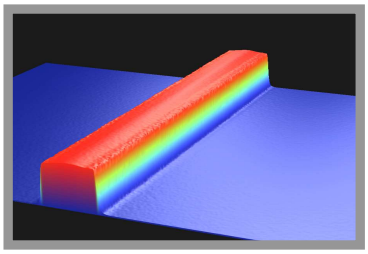

Fig. 1: Channel optical waveguide fabricated from hybrid sol-gel materials

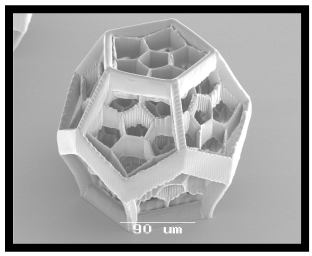

Fig. 2: 3-D structure fabricated from hybrid sol-gel materials

To implement a circuit of microfluidic channels in sol-gel materials, it is of great importance to study how the material surface interacts with fluids, i.e. whether it attracts or repels fluids. We propose to study this physical property on several different sol-gel formulations via the contact angle technique. Surface post-treatment with ozone will also be carried out and compared to non-treated samples. Then a microfluidic circuit will be fabricated allowing the correlation of fluid flow speed with the measured surface properties.

This project offers an excellent opportunity to work on a multidisciplinary project involving physicists, chemists and biotechnologists. The results achieved in this project will feed into a new project on the development of an optical waveguide-based sensor for microbial sensing for marine applications.

Key Outputs: Microfluidics, Hybrid sol-gel, Photocurable, Photopolymerization, Contact Angle

[1] "The role of photoinitiator and chelating agent in the fabrication of optical waveguides from UV-photocurable organo-mineral sol–gel materials." R. Copperwhite et al., *Journal of Non-Crystalline Solids, 510, 2006, Pages 334-338.*

[2] "New organic-inorganic sol-gel material with high transparency at 1.55 µm.". M. Oubaha et al., Optics Communications, Volume 253,(4-6), 2005, Pages 346-351.

Key Impacts: We are seeking an applicant who has experience in the accurate and precise acquisition, recording and analysis of measurements (comprehensive training will be provided for all equipment). You will be working in a team environment so good written and oral communications skills will be required. Experience with manipulation of chemical compounds would be an advantage.