UKFN SRV Report

Project Title: Smart materials and surfaces enabled resilience engineering technology
Duration: 2018.02 – 2018.11
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1. Aims of SRV Project

This SRV is aiming to support the research on smart materials and surfaces enabled resilience engineering technology, where we are looking forward to integrate the experiences from Northumbria (materials and mechanics) and Heriot-watt (Micro-/nano-fabrication), to generate the world-leading outputs and grant applications to research council.

2. Quality of Research in this SRV

Calcium deposition and biofouling on the surface of optical implants are major problems that frequently occur after surgery. Both of these problems are related to the material and the local micro-environment (*J Cataract Refract. Surg.* **36**, 2010; *J Cataract Refract. Surg.* **39**, 2013). This SRV addressed the above challenges by drawing from the UNN PI's expertise in PNIPAM gels, mechanics and device engineering technologies (*Adv Mater*. **25**, 2013; *Adv Fun Mater*. **26**, 2016; EP/N007921), and the HWU investigator's extensive expertise in micro-/nano- soft surface engineering and evaluation of their anti-biofouling properties. While we used chemical modifications to obtain the optimal responsive property, micro/nanotechnologies, such as focused ion beam (FIB) machining and ultra-precision surface milling, can be used to tune surface wetting condition on polymer surface by creating nano-bumps and grooves, and which help reduce tissue adhesion (anti-biofouling) and reduce calcification.

During this project, we fabricated a range of topographical patterns on polymer surfaces in Heriot-Watt (**Fig. 1**), and assessed the wetting condition for their potential to resist calcification and bio-fouling. The polymer surface was firstly machined by ultra-precision milling (**Fig 1a**) to optimise the profile and the haptics, followed by a single point diamond turning process using FIB machined multi-tip diamond cutting tools and/or direct FIB milling (**Fig 1b-c**). The studies on surface wettability took place in Northumbria (**Fig 1d**). Outcomes are summarised in the following Section 3.

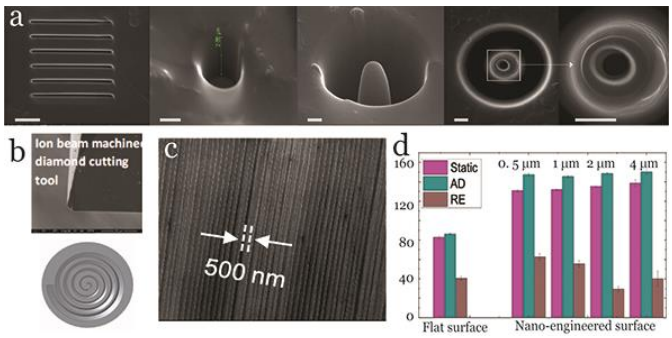

Fig. 1 (a) FIB engineered nanostructures, from left to right, lines pattern, nano-hole, nano-probe, nano-tunnel, the scale bar is 500 nm; (b) FIB machined multi-tip diamond cutting tools and attempted spiral pattern; (c) SEM image of nano-groves on HDPE surface; (d) contact angle results for HDPE surfaces with nanostructure of 500nm, 1 μm, 2 μm and 4 μm gratings.

3. Achievements and outcomes in this SRV

3.1 Paper publications

- ***3.1.1*** *Ben Xu et al, Recoverable and Self-healing Electromagnetic Wave Absorbing Nanocomposites,* ***Composites Science and Technology*** 2019**,** accepted. (IF=5.16, Top 1% journal in Materials science, Composites)
- ***3.1.2*** *Ben Xu et al, Advances in Biological Liquid Crystals,* ***Small*** 2019**,** minor revision. (IF=9.6, Top 10% journal in Materials science, Multidisciplinary)
- ***3.1.3*** *Ben Xu, Jining Sun et al, Enhancement of Surface Wettability via Micro and Nanostructures by single point diamond turning,* ***Nanotechnology and Precision Engineering*** 2019**,** under review.

3.2 Conferences, Workshops and Seminars

- ***3.2.1*** *The UKFN Annual Conference 2018, Manchester, poster presentations by two students.*
- ***3.2.2*** *The 25th Annual Conference for the Society of Chemical Industry-The Chinese Society of Chemical Science and Technology in UK (SCI-CSCST), Manchester, 2018, oral and poster presentations by two students.*
- ***3.2.3*** *The Silk Road International Symposium for Distinguished Young Scholars, Xi'an, China, Apr. 2018, INVITED TALK.*
- ***3.2.4*** *The University Alliance of the Silk Road & 1st Academic Forum on Charismatic Chemical Engineering, Xi'an, China, Jul. 2018, INVITED TALK.*

3.3 Conferences, Workshops and Seminars

- ***3.3.1*** ***3rd presentation award (****Sreepathy Sridhar****) and poster award (****Ding Wang****) in the 25th annual conference for SCI-CSCST* ***(2018).***