QUB - Mechanical and Aerospace Engineering PhD Project 2019-2020

Title: Polymer Nanocomposites for Cardiovascular stent applications

Project description: Coronary heart disease is the number one killer in the world. It is caused by narrowing of the artery (fig 1a) and is typically treated through the deployment of a metal stent (fig 1b). New materials are now opening clinical treatments in which a temporary scaffold is used to support regeneration of healthy tissue. The specific need for this research is for thinner and stronger bioresorbable vascular scaffolds (BVS) for coronary heart disease (Fig 2a). BVS are poised to replace metal stents due to the excellent clinical outcomes: beyond keeping the vessel open during the first six months after surgery, the BVS leaves behind a healthy blood vessel after the scaffold is gone, being completely absorbed by the body approximately two years after surgery. The material that has achieved clinical approval for BVS is poly(L-lactic acid), PLLA. It is not as strong and stiff as metals, so the scaffold is three times thicker than metal stents (fig 2b), making it more difficult for surgeons to move through arteries to reach the site of the lesion. Thinner Scaffolds that can be seen by x-ray imaging during surgery would facilitate adoption of the technology and benefit thousands of patients worldwide. The proposed project will provide the fundamental understanding needed to reinforce PLLA by tungsten disulphide (WS2) nanotubes to achieve both the strength and x-ray opacity needed.

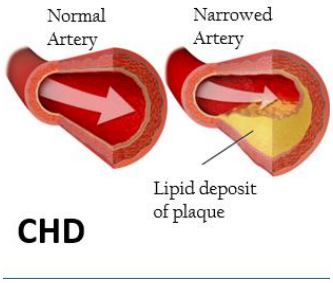


Figure 1a: Coronary heart disease

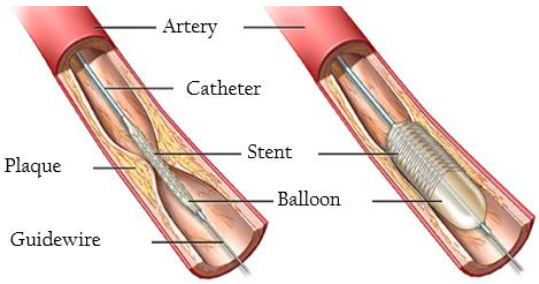
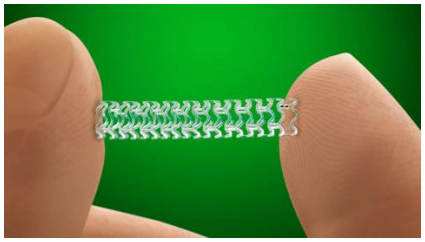
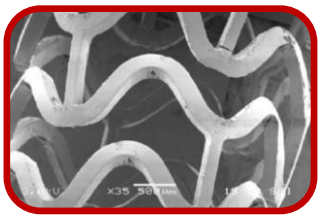


Figure 1b: Metal stent typically deployed





a **b**

Figure 2: (a) Bioresorbable vascular scaffold, SEM image highlighting thick struts

Aims and Objectives:

The aim is to investigate how the addition of tungsten disulphide nanotubes (WS_2NTs) to poly(l-lactic acid) affects the mechanical behaviour and microstructure of the polymer and to study the effect of biaxial deformation on the properties of the nanocomposite. The objectives will be

1. Investigate the mechanical properties of PLLA nanocomposite at different loadings of WS_2NTs and determine the optimum loading of WS_2NTs.
2. Investigate the effect of stretch ratio during biaxial deformation on stiffness, strength and microstructure of the nanocomposite.
3. Characterise the effect of WS_2NTs on microstructure by means of microscopy, x-ray diffraction and birefringence testing.

Key skills required for the post: Good knowledge in mechanics of materials.

Key transferable skills that will be developed during the PhD:

Polymer nanocomposites, polymer characterisation, biomedical engineering, matlab/python

Lead supervisor:	Dr Gary Menary, telephone 00442890 974780, email: g.menary@qub.ac.uk
Guaranteed stipend:	£14,925/year. Fees at ~£4k/year. Note: UK/EU applicants only. Stipend and fees are **NOT** available for international applicants.

Conditional top-up available:	Subject to availability, £3000/year for students with 1st class honours and exceptional performance at interview.
PhD students in the School have the opportunity to apply to be demonstrators on undergraduate modules. Compensation for this is in addition to the amounts above and can amount to £2000/year.	

Queens University Belfast is a diverse and international institution which is strongly committed to equality and diversity, and to selection on merit. Currently women are under-represented in research positions in the School and accordingly applications from women are particularly welcome.