NDnano Summer Undergraduate Research
2016 Project Summary

1. Student name: Eoin O'Sullivan

2. Faculty mentor name: Dr. Tiffanie Stewart

3. Project title: 'Production of Magnetoelectric Nanoparticles and Functionalization for Increased Biocompatibility'

4. Briefly describe any new skills you acquired during your summer research:
- Being able to work independently as a researcher.
- Training on instruments fundamental to a material scientist.
- Presentation skills
- Being able to collaborate and learning to take the initiative when needed.

5. Briefly share a practical application/end use of your research:
Magnetoelectric nanoparticles can be functionalized with drug molecules and used to treat diseases such as cancer. My research focused on functionalizing the nanoparticles in an attempt to stabilize them in the high ion concentration found under physiological conditions. PDA (polydopamine) showed good results with good coverage of the nanoparticles, increasing their zeta-potential (a measure of stability in solution) and increasing their functionalizability.

Begin two-paragraph project summary here (~ one type-written page) to describe problem and project goal and your activities / results:

A novel drug therapeutic technique is being developed using magneto-electric nanoparticles (MENs). These nanoparticles, which have a magnetostrictive core and a piezoelectric shell, can preferentially target tumour cells by inducing an electric field generated by the application of an external magnet, creating localised changes in the permeability of the cells. The cancerous cells have a lower threshold to this induced electric field and thus absorb the MENs more readily in comparison to normal cells. However, problems with aggregation of the MENs under physiological conditions have hindered this method of drug delivery. I aimed to functionalize the MENs with two types of polymer; polydopamine (PDA) and N-(6-aminohexyl)-3-aminopropyltrimethoxy silane (AHAPS). PDA was chosen as it is biocompatible and shows negligible toxicity, it possesses zwitterionic properties – meaning that in acidic pH it is protonated and gains a positive charge and in basic pH it is deprotonated and has a negative charge. PDA also gives great coverage on the nanoparticle and is easily functionalizable. AHAPS is a positive polymer that was tested to see its effects on the stability of the MENs once functionalised.
Spectroscopic studies were used to show whether or not the polymer coatings had successfully adhered to the surface of the MENs. X-ray photoelectron spectroscopy (XPS) was used to qualitatively determine the elements found on the surface of the MENs. Dynamic light scattering

(DLS) were carried out to determine the zetapotential (a measure of stability in solution) and the average particle size. Atomic force microscopy, scanning electron microscopy and transmission microscopy were used to directly image the MENs, showing their size before and after functionalization.
Results showed that both polymers had adhered to the MENs, with PDA showing a huge spherical polymerization around the MENs. AHAPS showed a much smaller coating on the nanoparticles. Zeta potential was varied with each coating. Dynamic light scattering tests on the average particle size showed huge aggregation in all samples of MENs only, MENs@PDA and MENs@AHAPS. However, direct imaging with AFM, TEM and SEM did not show this so more investigation here would need to be done. Future work on controlling the size of the PDA layer using a ratio of H_2O:EtOH as a solution could show promise.