## Project overview

New polymers are continually needed to meet the modern world’s evolving challenges. The safe dissipation of impacts and vibrations is one such area where we need new soft materials to (for example) protect our heads in bicycle accidents, and in coatings to protect wind turbine blades against the effects of rain erosion in the harsh environment of the North Sea.

These applications require design of finely balanced viscoelastic materials which: are elastic and shape-retaining; can dissipate large quantities of mechanical energy; and are light enough to meet the broader application requirements.

One such promising class of materials to address these challenges are liquid crystal elastomers (LCEs). The dissipative properties of LCEs are further enhanced when macroscopically aligned – for instance through 3D printing using direct-ink writing. On a simple level, the 3D printing process causes shear-alignment of the liquid crystal polymer chains as they are extruded from the printing nozzle. In reality, the structure and magnitude of the alignment has a complex dependence on many parameters such as viscosity, print speed, and nozzle geometry.

This project will investigate how printing parameters affect the chain alignment and physical properties of printed liquid crystal elastomers. This project has the flexibility to approach the problem from an experimental or simulations (or both!) point of view depending on the student’s background, interests and skills. From a practical point of view, the research would focus on: printing LCE devices and systematically changing the printing parameters; measuring the structure and order of printed devices; and characterising the physical properties of printed materials. From a simulations point of view, this project would create a fluid dynamics model of 3D printed LCEs to understand how print conditions and ink properties interact to dictate the ordering in, and properties of printed devices. Both approach will aim to enable the design of 3D printed LCE devices with specific impact absorbing and vibration damping applications.

## Supervision team

The project supervision team is made up of Dr Devesh Mistry (experimental soft matter physics – liquid crystalline polymers), Dr Oliver Harlen (applied mathematics - fluid mechanics), and Prof Daniel Read (applied mathematics - polymer structure and dynamics).