PhD PROJECT PROPOSAL

## **PhD Project Title**

## Understanding and improving the topography of additively manufactured implant surfaces.

## **PhD Supervisory Team**

Principal Supervisor: Dr Sophie Cox, s.c.cox@bham.ac.uk, Centre for Custom Medical Devices, School of Chemical Engineering.

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Industrial Partner: Renishaw PLC

## **Project Abstract**

The aims of this project are to study and quantify the formation of surface roughness on selective laser melting components. From this point we may develop or refine post-processing treatments that specifically compliment these roughness features, and explore the interaction of these newly formed surfaces with cells and bacteria.

The objectives for this project are:

* To characterise surface adhered powder and by experimentation determine the key adhesion mechanisms
* To characterise and quantify the underlying surface topology with respect to process parameters and melt-pool behaviour
* To develop or refine novel surface improvement techniques by processing or post-processing methods
* To biologically assess these new surfaces with respect to bacteria and cell behaviour

## **Detailed Project Description**

The design freedoms associated with the layer-by-layer processing of material in additive manufacturing (AM) have led to widespread use of these technologies in medicine. In particular, personalised metallic devices produced via laser-based AM processes have been adopted for replacement of skeletal tissues. Selective laser melting (SLM) is one such technique that employs a laser to selectively melt metal powder particles together. The surface of implants produced via SLM present topographies distinct from conventionally manufactured devices. Typically, they are characterised by a combination of the ‘stair-step’ effect and powder adhesion. The extent to which each of these factors governs the ultimate surface structure depends on processing parameters, local build angle, and feedstock amongst many other parameters. Traditional roughness characterisation techniques rely on a line of sight and therefore struggle to truly capture representative measurements of this complex surface (Figure 1(a)). Densely adhered powder particles may present a ‘false’ upper surface, and the often-tortuous profile of the underlying material is drastically oversimplified by traditional probe or normally viewed optical methods.

This PhD project will seek to explore the duality of SLM implant surfaces and gain new understanding of the mechanisms involved in surface powder adhesion and underlying topology. From this new knowledge the project will then focus on strategies to control surface formation during processing and developing post-processing methods that best remove roughness without sacrificing part accuracy or production time. Alongside these goals the student will be expected to develop novel techniques to characterise the topology of AM implants.

## Figure 1: Example surface produced by selective laser melting demonstrating partially melted powder particles and underlying roughness profile