Repeatability and tailoring of contact stiffness via micro-structured surfaces

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Interfaces can be considered a weak link in engineering design due to their unpredictable and unrepeatable properties. Surfaces produced through traditional machining methods exhibit mechanical properties that are difficult to define and model. This makes the interfaces difficult to optimise and tailor for design. The work presented here aims to bridge the gap between materials mechanical engineering and microfabrication techniques. Allowing micro-structured surfaces that have repeatable and tailored properties to be produced, with a specific focus on the interfacial property of contact stiffness. Contact stiffness can influence damping and vibrational response which is important to the design of many machine components.

Microfabrication techniques enable the production of structured surfaces through advanced fabrication methods. The techniques allow for extremely accurate design to be achieved, enabling tight tolerance on the topographical designs of an interface. This may eliminate the unpredictability and multiscale attributes of interface features associated with both traditional and more advanced manufacturing techniques such as 3D printing. Further, by varying feature geometry, it may allow interfaces to be tailored to suit specific joint specifications.

The initial stages of the project focused on producing micro-structured polymer surfaces for mechanical testing. A novel fabrication method for producing the micro-structured interfaces in polycarbonate was developed. The micro-structured interfaces were then mechanically tested to examine their normal contact stiffness response. The results of the mechanical tests were compared to FE simulations to examine how the micro-structured interface behaviour contrasted with idealised models. Initial tests confirmed that very repeatable normal contact stiffness could be achieved through micro-structuring. Subsequent work explored how varying the geometry of the micro-structured interfaces could influence the normal contact stiffness achieved. The true contact area of the interfaces was varied and then the samples were mechanically tested. This allowed for examination of how different percentage contact areas can influence the measured values of normal contact stiffness.

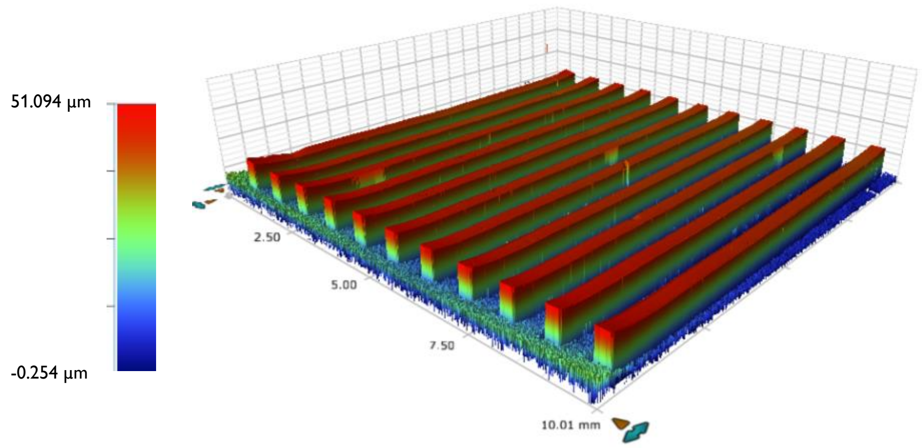

Fig. 1: Optical profilometer scan of structured polycarbonate sample produced by injection moulding, nominal sample area 10x10 mm.