MONASH University
Engineering

PhD Research Project

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Design of hybrid materials using multimaterial 3D printer

The last decade has seen significant advances in the development of new composite materials based on the use of inner architecture as an additional degree of freedom [1]. These materials, often inspired by natural materials, achieve outstanding mechanical properties and possess a multitude of functionalities [2]. The basis for their superior mechanical properties is a complex hierarchical architecture [3, 4]. Some well-known examples are bone, nacreous abalone shells or hexactinellid sponges. Recent advances in 3D printing allow fabrication of composites with high levels of complexity of inner architecture at micrometre-scale resolution [5].

In this project, a number of different base materials will be used to manufacture composites with superior mechanical properties compared to their single constituents. The main focus of this PhD work will be on manipulating the properties of the composite by controlling the inner architecture at different length scales and optimising the material selection. Furthermore, this research will exploit the benefits of the geometry of the structural elements as a degree of freedom by using the concept of 'topological interlocking' [6, 7]. This relatively new materials design principle is based on segmenting a structure into identical elements with a specific geometrical shape. By virtue of this shape and the arrangement of the elements, each of them is held in place through support of neighbouring elements without the use of any connectors or binder. Not only will the aforementioned 3D printing technology enable manufacturing of a plethora of geometries, but it will also allow for a precise placement and assembly of the parts to an integral structure. This will be performed using a state-of-the-art multimaterial 3D printer Stratasys® Connex500.

The experimental work will be complemented by the development of computational models to predict the trends in mechanical properties and suggest promising material architectures, as well as help optimising other properties. The supervisors are part of an international network working together on architecture materials, and the PhD

student involved in the project will have an excellent exposure to international collaborations.

Interested candidates should send their **CV**, **academic transcripts** and **copies of English Language tests** and a **short motivation statement** to Dr Andrey Molotnikov (Andrey.Molotnikov@monash.edu) before **28th of October 2016.**

Applicants should also refer to information on admission requirements and scholarship eligibility on the university website at http://www.monash.edu/migr/future-students/eligibility/phd

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[4] Buehler MJ. MRS Bulletin 2013;38:169.
[5] Dimas LS, Bratzel GH, Eylon I, Buehler MJ. Adv. Funct. Mater. 2013;23:4629.
[6] Estrin Y, Dyskin AV, Pasternak E. Mat Sci Eng C-Mater 2011;31:1189.
[7] Djumas L, Molotnikov A, Simon GP, Estrin Y. Scientific reports 2016;6:26706.