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**Title:** Expanding the envelope of material properties and functionalities through architecture and bioinspiration

**Abstract:** Development of materials with combinations of strength, toughness, and bioactivity is a tremendous challenge in science and engineering. Bioactive ceramics and glasses are stiff and strong and can bind to tissues very well *in vivo*, but they are brittle. On the other hand, metals and polymers are tough (not brittle) but are usually less stiff and less bioactive than ceramics. Natural materials such as bone, tooth enamel, and seashells show outstanding combinations of these properties. They therefore can be used as a rich source of inspiration for next-generation materials and biomaterials. They are composed of mineral building blocks separated by biopolymeric interfaces and arranged in designed hierarchical architectures. The stiffness and strength of material come from the building blocks. The deformability and toughness come from the architecture and interfaces that enable relative sliding and rotation of the building blocks. The bioactivity comes from the material composition. This talk will provide an overview of our activities in using bioinspiration, architecture, and advanced manufacturing techniques to develop materials with combinations of strength, toughness, and bioactivity. We will also present our activities in determining the micromechanics of the resulting materials using a rich set of advanced experimental, analytical, and numerical tools.

**Bio:** Mohammad Mirkhalaf is an Australian Research Council Early Career Discovery Fellow and Lecturer at the University of Sydney (USyd). His research focuses on tailoring materials' internal architecture to improve their mechanical properties and tissue regeneration capacity. He has published 24 original research articles and one invited review article in high-profile journals, two book chapters, a full US patent, and two patents at the corporation treaty stage. Of the journal articles, he is the first author on 15; these include publications in leading multidisciplinary journals such as *Nature Communications*, *PNAS*, and *Acta Biomaterialia*, and in leading disciplinary journals in mechanics (e.g., *Extreme Mechanics Letters & Int J Solids Struct*). He has been the first-named investigator on four successful grant applications (worth > A\$1M) and attracted several prestigious postdoctoral/graduate awards (total > A\$500K). His experience working at universities, government labs, and industries in Iran, Singapore, Canada, and Australia has enabled him to build solid national and international research partnerships. He has developed two new courses at USyd, and has contributed to teaching graduate and undergraduate courses at McGill University and Nanyang Technological University.