Guest editorial

PSU research review special issue on multiscale innovative materials and structures

Over the past few years, there has been a great scientific interest in developing innovative materials in research laboratories to be proposed, tested and used as novel engineering structures. This is also because of the increasing variety of novel technologies that allow to produce unconventional materials and structures at different scales (e.g. top down technologies, additive manufacturing, self-assembly and hybrid chemistry approaches, among others). Particularly active are the research areas dealing with sustainable composite materials, nanostructured composites and acoustic and mechanical metamaterials, which are receiving increasing interest from many scientific sectors including acoustics, aerospace, civil and mechanical engineering, medical diagnosis and remote sensing and sound and heat control, to name just a few examples.

The present special issue brings together researchers working at the forefront of applied mechanics, material science and engineering to further the current understanding of unconventional and innovative materials and structures at different scales. The covered topics include biodegradable composites for biomedical applications, green materials for the additive manufacturing of sustainable materials and structures, extreme mechanical materials with pentamode architecture, design and testing of novel tensegrity lattices and metamaterials, analysis of frequency bandagaps of lattice structures and use of composite materials for the strengthening of existing structures.

On the experimental side, a porous biodegradable Mg-3Si-5HA composite showing an excellent bioactivity and offering a channel/interface to MG-63 cells for attachment, proliferation and differentiation has been studied and characterized for biomedical applications. The use of primary recycled acrylonitrile butadiene styrene (ABS), polylactic acid (PLA) and high impact polystyrene (HIPS) in composite form for multimaterial 3d printing applications has also been investigated, through the experimental characterization of thermal and mechanical properties. In addition, an experimental study on the influence of the Kirkendall void issue on the long-term reliability of different semiconductor interconnects has been presented.

Mechanical modeling studies have been conducted with reference to the shear wave isolation properties of confined pentamode lattices, the geometrically nonlinear response of novel tensegrity structures and the influence of the size effect on the existence and properties of frequency band gaps in 2D lattices.

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Finally, a structure-scale study on the mechanical response of masonry structures strengthened through the application of composite materials has been presented with the aim of applying novel materials to the preservation of the cultural heritage.

The research reported in this special issue is aimed at serving as inspiration for new and continued research efforts in the broad area of multi-scale innovative materials and structures, both from the experimental and the modeling points of view.

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