Mechanics of extreme materials: graphene-related, composite, meta- and biological/bioinspired materials

Organizers:

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Materials that exhibit microstructures or hierarchically organized architectures at different scales have recently attracted wide interest in the scientific community as well as in industry because their macroscopic mechanical and, more in general, physical performance can be drastically and sometimes unexpectedly enhanced in terms of stiffness, toughness, resilience and strength as a function of the geometry and properties of the underlying structural arrangements occurring at micro or nano levels.
The unique combination of outstanding physical, mechanical, thermal, optical and electrical properties that makes graphene the ideal candidate for next generation technology is related to its band structure and the hexagonal arrangement of the carbon atom lattice. Due to the resulting physical properties, a variety of studies have proposed potential applications of graphene in high-performance sensors, devices and composites. However, graphene represents only an example of a wide class nowadays available 2D (i.e., one-atom thick) materials, including inorganic crystalline materials, like transition-metal dichalcogenides (MoS2, MoSe2, WS2, etc.), and 2D elemental materials (silicene, germanene, and phosphorene). The unique topology found in 2D materials poses many challenges to their implementation in artificial systems, and in spite of huge efforts from the scientific community, today there is still a lack of some fundamental information about for example their mechanical behavior and their interaction with other materials.
Extremely regular microstructural architectures can also be found in many soft biomaterials and hard tissues, from cells, arterial walls and animal skin to bone elements, determining surprising multi-scale physical properties such as lightweight stiffness, crack-stopping characteristics and form-finding based capabilities. Therefore, composite materials have been conceived mimicking these biological architectures and trying to replicate their macroscopic behavior starting from artificial base components, including nanomaterials with superior characteristics.
Another field where micro-structure, heterogeneity and architecture contribute in determining extreme macroscopic characteristics is that of elastic or acoustic metamaterials, which display dynamic effects such as band gaps, negative refraction, focusing or cloaking. Various designs have been proposed, with specific applications ranging from noise abatement to seismic shielding.
In this symposium, we aim to discuss the main challenges related to the application of graphene-based, bioinspired and meta materials, exploring the mechanical behavior of systems ranging from isolated sheets at nanoscale to nano-reinforced composite materials, to additionally investigate how nano- or micro-structures can influence adhesion, wrinkling, and mechanical and vibrational features, including stability, and auxeticity. Theoretical, numerical and experimental works are encouraged, including studies adopting a multi-disciplinary approach. Original contributions dealing with fundamental questions about the mechanics of 2D materials or reporting applications of 2D and 3D composites with microstructure or novel metamaterials are welcome.