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EDITED AND REVIEWED BY
Alberto Corigliano,
Polytechnic University of Milan, Italy

*CORRESPONDENCE
Nicola Maria Pugno,
nicola.pugno@unitn.it

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Editorial: Innovators in mechanics of materials

Seunghwa Ryu[1], Geoffrey Robert Mitchell[2], Antonio Caggiano[3], Raul A. Radovitzky[4], Patrizia Trovalusci[5] and Nicola Maria Pugno[6,7]*

[1]Korea Advanced Institute of Science and Technology (KAIST), Daejeon, Republic of Korea, [2]Center for Rapid and Sustainable Product Development, Polytechnic Institute of Leiria, Leiria, Portugal, [3]University of Genoa, Genoa, Italy, [4]Massachusetts Institute of Technology, Cambridge, MA, United States, [5]Department of Structural and Geotechnical Engineering, Sapienza University of Rome, Rome, Italy, [6]Laboratory for Bioinspired, Bionic, Nano, Meta Materials and Mechanics, Department of Civil, Environmental and Mechanical Engineering, University of Trento, Trento, Italy, [7]School of Engineering and Materials Science, Queen Mary University of London, London, United Kingdom

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Editorial on the Research Topic
Innovators in mechanics of materials

Mechanics of Materials is a rapidly evolving discipline driven by fundamental breakthroughs and feats of incredible ingenuity and innovation. None of these advancements would be possible without the talented community of researchers working across the world, from Nobel Prize winners to rising stars. This Research Topic aims to celebrate those scientists leading the way. Contributors to this Research Topic were either Editorial Board members of the Mechanics of Materials section, or were nominated by the Board for their research contributions. By showcasing their joint work here we aim to provide both a snapshot of the current field as well as a glimpse of what the next decade might hold. We welcomed Original Research and Review articles, on themes including but not limited to solid mechanics, adhesion, fracture mechanics, fatigue, dynamic fracture, plasticity, dislocations, nanomechanics, bio-inspired mechanics, mechanics of biological and soft materials, friction, lubrication and wear, thus tribology and nanotribology.

This Research Topic was therefore organized to provide a platform for researchers working in these fields, with 6 key contributions.

Kalpakoglou and Yiatros focused on "*Metal foams: a review for mechanical properties under tensile and shear stress.*" Due to their mechanical properties, metal foams are used in various fields. The aim of this paper was to collect different studies about the important mechanical properties of metal foams, such as Young's modulus, tensile and shear strength, relative density, etc. under tensile and shear loading. Gaps were identified in the methodological embodiments of the experiments due to the use of different standards, as well as in the calculation of mechanical properties through mathematical relations in tensile and shear, which led to deviations between the experimental results and these. Furthermore, this work recorded sequences and connections between experimental results of different tasks as well as solutions to the aforementioned issues.

Gazzola et al. focused on the "*Design and modeling of a periodic single-phase sandwich panel for acoustic insulation applications.*" Sandwich and composite panels are widely adopted in acoustic applications due to their sound insulation properties that overcome mass-law-based partitions in medium–high frequency regions. A key aspect in the design procedure of acoustic panels is the control of the resonance-dominated region of the sound transmission loss (STL) curve. Within that frequency range, such systems usually show acoustic weakness and poor insulation performances with respect to standard single-layer solutions. In this paper, the authors highlighted an innovative approach to the sandwich partition concept. A novel single-phase sandwich panel was realized by adopting a periodic repetition of a properly designed unit cell. The resulting internal truss structure is self-sustained, and its mechanical stiffness can be tuned to maximize the STL in the resonance-dominated region. A set of parametric analyses was reported to show how the topology of the unit cell affects the noise reduction properties of the panel. Experimental validation was performed on a nylon 3D-printed prototype. The proposed panel was then integrated with some locally resonant elements that can be adopted to further improve the low-frequency STL of the solution. Industrial and production considerations were also taken into account during the design process to make the solution industrially valid with a circular economy focus.

Duan et al. focused on "*A modified lower-order theory for FG beam with circular cross-section*." The modified uncoupled lower-order beam theory (LBT) based on the third-order shear deformation model was established for functionally graded (FG) beams with circular cross-section in this paper. Based on the shear stress free condition on the boundary of the circular cross-section, the bidirectional warping function of the axial displacement was mathematically derived for the first time. The power-law form in the radial direction was adopted to describe continuous variation of material properties. Generalized stresses were defined through the orthogonal form of the axial displacement and then expressed in the decoupling form, in which the shear correction factor and three relatively small coefficients were involved. The frame independent uncoupled equilibrium equations and the corresponding boundary conditions were obtained via the asymptotic principle of virtual work. The presented LBT was validated through the pure bending of a Clamped-Clamped FG beam by comparing the obtained deflections with the published results. Accordingly, the effects of shear, warping and stress mitigation acting on the cross-section influenced by the power-law exponent have been described graphically and discussed.

Cabras et al. focused on the "*Electro-chemo-mechanics of solid state batteries with lithium plating and stripping*." This paper was about a novel, thermodynamically consistent formulation for small strains continuum electro-chemo-mechanics applied to all solid state batteries, which are claimed to be the next-generation battery system in view of their safety accompanied by high energy densities. The response of a cell, made of a lithium metal foil, a solid electrolyte, and a porous $LiCoO_2$ cathode, has been investigated in terms of quantities of interest such as the electric potential, the lithium concentrations profiles, displacements, and stresses. The plating and stripping of the lithium has been considered together with the volumetric evolution of the porous cathode. Together they contribute to the outbreak of mechanical stresses, which may influence the life cycle of a battery.

Zhao and Hu focused on the "*Study on the size effect of elastic modulus of rock considering the joint spacing*." The relationship between the rock's elastic modulus and deformation characteristics, affected by joint spacing and ductility, was not determined. This study investigated the size effect of the elastic modulus of rock with parallel joints using numerical simulation and regression analysis. The results showed an exponential relationship between elastic modulus and spacing of parallel joints and a negative exponential relationship between elastic modulus and rock size. The characteristic size of elastic modulus has a power function relationship with the parallel joints spacing, and the characteristic elastic modulus of rock has a power function relationship with the parallel joints spacing. The general and specific forms of these relationships were provided. Establishing these relationships allows for predicting and calculating the elastic modulus of the mine rock mass and serves as a reference for the deformation analysis of the rock.

Alrashdi focused on the "*Mixed convection and thermal radiation effects on non-Newtonian nanofluid flow with peristalsis and Ohmic heating*." This investigation explored the heat and mass transfer properties of a non-Newtonian nanofluid containing graphene nano-powder and ethylene glycol during peristalsis. The rheological characteristics of the nanofluid were determined using the Carreau-Yasuda model, and various factors such as viscous dissipation, Lorentz force, Ohmic heating, and Hall effects were taken into account. Mixed convection and thermal radiation effects were also considered in the analysis, and the problem was mathematically described using the long wavelength and low Reynolds number approximations.

With these diverse papers, the Research Topic provides an overview of some of the most promising advances in current mechanics of materials research and is aimed at stimulating cross-fertilization between researchers in the field and the readers of the journal, further contributing to this still growing fundamental discipline.

Author contributions

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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