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Auxetics in Smart Systems and Structures 2015

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Auxetics is a term that defines classes of materials and structures that exhibit a negative Poisson's ratio. As such, they are part of a more general family of materials displaying 'negative' material properties, like negative stiffness, negative thermal expansion, negative compressibility and negative effective mass. The negative Poisson's ratio effect creates a transverse expansion when a solid is loaded in tension, and this behaviour is counterintuitive to our experience of 'classical' materials. The auxetic effect generates large volume deformations, but also other unusual deformation mechanisms that lead to energy absorption and tailoring of the dynamic properties of these materials. Auxetics are considered to be a type of smart material or structure because of their capability of shape changing and hosting multimaterial configurations that give significant degrees of freedom to the modern materials system and design engineer.

The papers in this focus issue provide a broad range of examples of the multifunctional capabilities of auxetics. Classical elasticity and how shear correction factors are affected by negative Poisson's ratio materials are described by Lim. Strek et al show auxeticity in sinusoidal ligament systems, while novel micromechanical deformation mechanisms present in auxetic configurations are discussed by Kochmann et al and by Rueger and Lakes. The latter paper also provides experimental evidence of Cosserat elasticity in foams. Continuing with multiscale aspects, Ha et al show configurations of 3D chiral lattices, and Lisovenko et al provide evidence of auxeticity at the nanoscale with tubular structures made from orthorhombic crystals. Wojciechowski et al suggest a very interesting concept to induce auxeticity in Yukawa (screened-Coulomb) molecular systems through a nano-channel topology. Wave propagation has always been a key topic in the field of auxetic systems, and this focus issue provides some excellent examples. Longitudinal wave motion in width-constrained auxetic plates is described by Lim. Bacigalupo et al provide an optimised design of auxetic hexachiral metamaterials with internal resonators, while Pal et al show the influence of large deformation preloads in the wave propagation of general and auxetic hexagonal configurations. Mukherjee et al show a hybrid cellular auxetic concept able to produce and engineer bandgaps at different frequency bandwidths. The vibroacoustic optimisation of sandwich plates with gradient auxetic core is analysed by Ranjbar et al.

The focus issue also shows some examples of applications of auxetics in various engineering fields. Shil'ko et al describe the different performances of muscle actuators based on the use of negative or positive Poisson's ratio materials. Alderson et al show very interesting experimental results related to the impact of auxetic foam pads for sport applications. The applications of auxetic topologies to manufacture ceramics sensors and devices through lithography is described by Diaz Lantada and co-workers.

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