Multifunctional Negative Poisson's ratio (Auxetic) Honeycomb Cores with Embedded Piezo-ceramic Patches.

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KEYWORDS: Negative Poisson's ratio, Chiral, Honeycomb, Multifunctional, Piezo-ceramic

Honeycombs are in widespread use as cores for sandwich structures. Auxetic materials (materials with a negative Poisson's ratio) expand laterally when stretched. In this paper we consider auxetic honeycomb cores consisting of chiral units of cylinders and tangentially attached ribs. The use of these cylinders and ribs allows the decoupling of the shear stiffness and compressive strength, with the ribs providing the shear stiffness and the cylinders the compressive buckling resistance. Auxetic structures are proposed because they display high in-plane shear stiffness and synclastic curvature, that is, they form domes rather than saddle structures, making them ideal for consideration as next generation sandwich cores.

Furthermore, we have embedded a piezo ceramic transducer (PZT) inside the wall of an auxetic chiral honeycomb structure. The piezo ceramic transducer can be used in either active or passive modes providing increased functionality to the core as either an actuator promoting in plane or out of plane shape changes or as a sensor for structural health monitoring (SHM). SHM can be achieved either through direct measurement of deformations inside the honeycomb or via NDA type vibrational structural interrogation.

In this paper we demonstrate manufacture of auxetic chiral honeycombs with embedded PZTs and show how a PZT transducer can be used to actively drive the deformation of the structure and to detect applied deformations and vibrations. Finite element modelling simulating this experimental work is used to optimise the location of the patch within the structure and for further development of the whole system.