Two major research projects for the Auxetics group of the University of Malta in modelling and design of multi-functional materials

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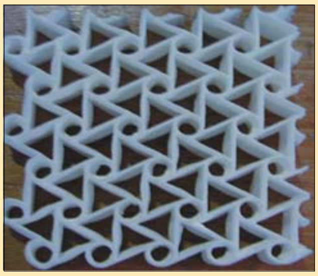
In 2005, the Auxetic Materials Research Group of the Faculty of Science, University of Malta led by Dr Joseph N Grima started its work on two major research projects: the CHISMACOMB project, a three million Euro EU FP6 funded project, of which more than a quarter of a million Euros were awarded to the University of Malta; and one on modelling of materials with unusual thermal and mechanical properties, a LM28,700 project funded through the National RTDI programme administered by the Malta Council for Science and Technology (MCST).



CHISMACOMB (an acronym for Chiral Smart Honeycombs), is the result of a collaborative effort involving an international network consisting of production companies, research institutes and universities coming from five other EU countries (Germany, Greece, Italy, Poland and United Kingdom) and two Associated States (Israel and Romania). The consortium is led by Dr Fabrizio Scarpa from the University of Bristol, UK.

The CHISMACOMB project will investigate and develop a novel concept of cellular chiral honeycombs with embedded PZT sensors/actuators which can be particularly useful in aerospace and marine applications. Through this project, the consortium will be modelling and producing sandwich structures incorporating components having Negative Poisson's ratio (auxetic) which will have enhanced mechanical and dielectric properties. The design will be such that we will be able to include sensor and actuators in its microstructure with the result that we produce highly innovative smart sandwich structures.

The novel structural core concept will have paradigmatic properties compared to classical honeycomb materials currently used to manufacture sandwich components with complex shapes, and multifunctional active characteristics for structural health monitoring and electromagnetic compatibility applications, with no detriment to the structural integrity of the components. At the moment, no single core material can be used in a multifunctional design context like the one the consortium is developing.

The CHISMACOMB work involves base multiphysics modelling, sandwich structure design, embedding structural health monitoring and microwave absorption capabilities with custom-designed microsensors and actuators in the material configurations. The University of Malta is primarily involved in the multiphysics modelling and currently employs four full-time researchers (Ruben Gatt, Pierre Sandre Farrugia, Victor Zammit and Trevor G. Chricop-Bray) on this project. It is envisaged that the know-how developed will be ideal to stimulate the development of intellectual properties, innovative end-user products and technology transfers.

The other project in hand which is financed through the National RTDI programme has offered the University a possibility to upgrade the research facilities in use by the auxetics research group, and this will enable it to further enhance its research efforts and to remain a key international player in the field of auxetics and related materials. The purpose behind this research project is to design or study new/already existing structures and materials which exhibit negative Poisson's ratios (auxetic) and/or negative thermal expansion coefficient (NTEC) in an attempt to produce new materials and structures with these properties. The project will also study the possibility that these two unusual properties co-exist, and to study the effects of stress / temperature changes on the thermal / mechanical properties respectively. In view of the many additional beneficial effects in the materials' properties that result from having negative Poisson's ratios or negative thermal expansion, this work is also expected to result in development of intellectual properties which in the future could be incorporated in innovative end-user products.

Selected publications (2005):

- J.N. Grima, R. Gatt, T.G. Chircop Bray, A. Alderson and K.E. Evans, "Empirical Modelling Using Dummy Atoms (EMUDA): An alternative approach for studying 'auxetic' structures," *Molecular Simulation*, 31 (2005), p. 915-924.

- J.N. Grima, R. Gatt, A. Alderson and K.E. Evans, "On the potential of connected stars as auxetic systems," *Molecular Simulation*, 31 (2005), p. 925-935.

- J.N. Grima, J.J. Williams, R. Gatt and K.E. Evans, "Modelling of auxetic networked polymers built from calix[4]arene building blocks," *Molecular Simulation,* 31 (2005), p. 907-913.

- J.N. Grima, J.J. Williams and K.E. Evans, "Networked calix[4]arene polymers with unusual mechanical properties," *Chem. Comm.,* (2005) p. 4065-4067.

- [1]J.N. Grima, R. Gatt, A. Alderson and K.E. Evans, "On the origin of auxetic behaviour in the silicate alpha-cristobalite," *J. Mater. Chem.*, 15 (2005) p. 4003 – 4005.

- J.N. Grima, R. Gatt, A. Alderson and K.E. Evans, "On the auxetic properties of 'rotating rectangles' with different connectivity", *J. Phys. Soc. Jpn.*, 74 (2005) p. 2866-2867.

- N. Gaspar, X.J. Ren, J.N. Grima, C.W. Smith and K.E. Evans, "Novel Honeycombs with Auxetic Behaviour," *Acta Materiala,* 53 (2005) p. 2439-2445.

- J.N. Grima, A. Alderson and K.E. Evans, "An alternative explanation for the negative Poisson's ratios in auxetic foams," *J. Phys. Soc. Jpn.*, 74 (2005) p. 1341-1342.

- J.N. Grima, A. Alderson and K.E. Evans, "Auxetic behaviour from rotating rigid units," *Phys. Stat. Sol. (b)* 242 (2005) p. 561-575.

[1] Selected as Hot Paper by the editors of *Journal of Materials Chemistry.*

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