## Offre de thèse en cotutelle LPCM (UMONS) – LAMIH (UPHF)

***Programmation de structures auxétiques par impression 3D pour la conception de métamatériaux dynamiques***

***Programmation of auxetic structures by 3D printing for the design of dynamic metamaterials***

In the frame of this PhD, involving the Laboratory of Polymeric and Composite Materials (LPCM) of the University of Mons (UMONS), and the Laboratory of Industrial and Human Automatic Control and Mechanical Engineering (LAMIH) of the University Polytechnique Hauts-De-France (UPHF), mechanical metamaterials, which are artificial materials that obtain unprecedent responses to mechanical forces due to their specifically designed architectures, will be targeted. Herein, the shape morphing of the metamaterial architectures will be introduced via the spatio-selective integration of responsive actuating elements to reconfigure the mesoscale unit cell geometry to reach programmable auxeticity on the macroscale. While most of these carefully designed architectured materials consist of a single material, the right distribution of actuating with non-actuating struts will programmed using advanced additive manufacturing technologies to form a continuous unit cell lattice with change in Poisson's ratio. To that end, dynamically modified polymeric systems, where specific bonds or interactions can selectively undergo reversible breaking and restoration under certain conditions, will be synthesized based on associative or dissociative (or combination thereof) pathway as responsive actuating elements. A variety of dynamic interactions, such as multiple hydrogen bonding, metal-ligand coordination and ionic bonding, could be used to design such systems. Overall, this architectural shape morphing will result in different responses to applied mechanical forces, that is, the resulting Poisson's ratio will be tuned from negative over zero to positive values through post-fabrication alteration of the structural angle. In addition, the geometrical reconfiguration with resulting programmable auxeticity will be modelled to predict the mechanical behavior under various loading rates. For that purpose, rheological approach could be used based on the experimental identification of the kinetics of the dynamic interactions.

**Candidate profile:**

The candidate must have a good background on polymer materials from the macroscopic point of view (mechanical behaviour) to the microscopic point of view (microstructure deformation, conformation,…). A knowledge on synthesis of polymer will be also appreciated. The candidate will obtain, at the end, a doctor grade in Belgium and in France.

**Location: Mons (Belgium) and Valenciennes (France)**

**Contacts**

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**Required documents**

CV + motivation letter + transcript of records (bachelor and master level)

**References:**

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- Skarsetz O., Slesarenko V.and Walther A. (2022). Programmable auxeticity in hydrogel metamaterials via shape-morphing unit cells, Advanced Science, 9,2201867.