Large area temperature sensors from natural polysaccharides

Sensing temperature has a variety of applications. For instance, temperature feedback control is required for the monitoring of industrial processes (i.e. polymers molding or chemical processes efficiency) or in environmental studies (i.e. groundwater–surface water interaction, snow hydrology or land surface energy exchanges[1,2]). Another application is medical monitoring of patients, as in the case of transplants[3] or infections[4]. Temperature sensing also opens up new applications in bioengineering[5-11]: temperature sensing artificial skins can be employed to augment the interaction of prosthetic limbs or robots interactions with humans or the environment.

Recently, the response of natural polymers to temperature has been reported[12,13]. In particular, it has been shown that pectin, a component of all higher plant cell walls, has a giant temperature response and sensitivity[12,13]. This is a consequence of the following mechanism: in the presence of divalent metal ions, the crosslinks of pectin molecules can generate a complex hydrogel network trapping the ions, increasing the temperature will diminish the crosslinking of the pectin network, liberate the metallic ions and increase as a consequence ionic conduction[12-14].

The exploitation of these materials enables the manufacturing of a completely new class of sensors ranging from large area, flexible, transparent and ultra-sensitive membranes to extremely responsive and cost effective bolometers for IR detection.

The present PhD project will explore several novel directions of this new class of materials:

- Manufacturing of sensing areas at macroscopic (cm) and microscopic (µm) scale
- Testing of coupled mechanical and thermal properties of the films
- Testing the measurement capacities of sensing areas
- Manufacturing using other polymers of the class of natural polysaccharides related to pectin (i.e. alginates, chitosans and celluloses) which promise to have similar sensing properties.

The PhD student will work in the Laboratoire de Mécanique des Solides (LMS) at Ecole Polytechnique, http://www.lms.polytechnique.fr under the supervision of Prof. Andrei Constantinescu and Dr. Gilgueng Hwang in Laboratoire de Photonique et Nanostructures (LPN) http://www.lpn.cnrs.fr/. The project will use the testing facilities of the plateforms *MiMeca* and *Platine* in LMS and the clean room facilities of the LPN. The project will benefit of the collaboration of the team of Prof. Chiara Daraio, Caltech, Passadena CA, USA.

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