CELLMEM

Cellulose-based shape-memory reflectors

ICMM-CSIC
University of Cambridge

Project context and objectives

Photonic crystals (PCs) have high impact in light technologies, with demonstrated performance both in the domain of light extraction and energy harvesting. A promising route that recently emerged for fabricating PCs, particularly chiral reflectors, is based on the self-assembly of cellulose nano-crystals (CNCs). The use of cellulose is extremely advantageous as it is the most abundant and renewable polymer available on Earth.

Shape memory polymers (SMPs) were proposed as an effective platform for photonic applications. SMPs have been employed for example for achieving thermoresponsive shape-memory photonic nanostructures that incorporate programmable optical properties or as potential shape programmable amplifying media.

In this project, we have explored possible synergies resulting from the combination of both fields of research. The main goal of our innovative approach was aimed at fabricating new multifunctional chiral cellulose membranes, benefiting from programmable features. Our objectives included co-casting of CNCs with SMPs (analysing effect of parameters such as temperature, solvents, and concentration of precursors towards the optimization of growth) and characterization of samples from structural, thermal, mechanical and optical points of view.

Brief description of the main results

Co-casting of membranes was tested using colloidal suspension with different concentrations of distilled water, ethanol and shape memory pre-polymer. For the moment, optimal parameters, which may lead to organized chiral membranes, could still not be identified. Direct infiltration of diluted pre-polymer in self-assembled membranes was also tested with encouraging results. The optical properties of the material changed significantly due to the increase of its effective refractive index, in particular, the colour of the membranes shifted dramatically from the green to red region of electromagnetic spectrum. Additionally, one immediate advantage derived from this strategy is the mechanical reinforcement of CNCs membranes.

Final results, potential impact and use

We were able to successfully infiltrate a shape memory polymer into chiral membranes composed of CNCs. On the other hand, more work is needed in order to definitely conclude about the effectiveness of using co-casting for producing this kind of novel membranes. The optimization of the explored fabrication strategies may deliver materials with functional impact, which are more environmentally friendly then present day mainstream technologies, for example based on silicon.