ABSTRACT

The use of latent heat storage materials containing phase change materials (PCM's) is an effective way of buffering thermal fluctuations and has the advantages of high-energy storage density and the isothermal nature of the storage process. The aim of this work was to develop novel heat management materials based on the encapsulation of PCM's for different applications of interest in refrigerated foods. To this end, the electro-hydrodynamic processing was used to encapsulate commercial PCM's with transition temperatures of interest in refrigeration and superchilling within different polymer and biopolymer matrices.

Initially, materials with heat management capacity to be used in refrigeration equipment and packaging applications were designed. To this end, thick slabs, multilayer heat storage structures and polystyrene foam trays containing ultrathin fiber-structured polystyrene/PCM coatings were fabricated through the encapsulation of commercial phase change materials (specifically paraffin's) within different polymeric matrices. The morphology, thermal properties, encapsulation efficiency and temperature profile of the just prepared structures and after three months of storage at 4 and 25ºC were evaluated.

However, the developed electrospun heat management materials showed a multiple crystallization profile, increased supercooling degree (difference between the melting and crystallization temperatures), low encapsulation efficiency and partial diffusion out of the PCM from the electrospun structures during ageing. Therefore, different strategies were been carried out to counteract these drawbacks. One the one hand, thermal energy storage systems including a PCM which crystallize at -1.5ºC were optimized by adjusting the solvent composition in order to obtain hybrid electrospun fibers with thermal properties similar to those of the neat PCM. On the other hand, a hydrophilic shell material based on polyvinylalcohol (PVOH) was used to encapsulate the PCM by using the emulsion electrospinning technique in order to improve the encapsulation efficiency. However, the hybrid structures thus prepared were highly soluble in water at high relative humidity conditions and an extra layer of a more hydrophobic material (polycaprolactone) through coaxial electrospinning was used to protect them from swelling. The use of the coaxial configuration was a good strategy to preserve the morphology of the electrospun structures when exposed to high relative humidity.