Nanofibrous polymeric membranes by coupling electrospinning and photo-induced crosslinking

Abstract

The main goal of the present research work was to prepare innovative polymeric fibrous membranes and to tailor their physico-chemical, mechanical and thermal properties through the coupling of versatile technique of electrospinning and various photo-induced crosslinking chemistries.

Electrospinning is a unique technique for fine fiber fabrication with diameters ranging from tens of nanometers to micrometers from polymer solution or melt. Photo-induced crosslinking reactions were selected due to their numerous advantages, such as short conversion times, low-energy consumption, ambient temperature operations, and selective curing with control both in time and space. The light irradiation to trigger the crosslinking reaction was performed either on the fabricated electrospun fibrous membranes or *in-situ* during the fiber formation. In the presence of photoactive agents (e.g., photoinitiators and photo-crosslinkers), covalent bonds between polymer chains were formed, building a crosslinked network. The electrospinning process, the chemistry of the systems and the irradiation conditions have been optimized to produce defect-free fibrous membranes and to assure an efficient crosslinking degree in order to increase their solvent and temperature resistance, as well as controlling morphology. The coupling of photo-crosslinking and electrospinning processes was proved to solve of the issue of electrospun fibers shape instability over storage time, when exposed to solvent, or subjected to temperature changes. Moreover, the processes were performed at ambient condition (room temperature) and water was mainly used as a solvent, limiting toxic and harmful substances thus raising the least possible environmental and health concerns.

This approach was successfully applied to different polymeric systems, namely chitosan-based, polyethylene oxide-based and polybutadiene-based materials. Accordingly, different polymeric fibrous membranes with enhanced properties and thus improved applicability were fabricated: Uniform and defect free chitosan-based membranes resistant to solvent are potentially promising for packaging application. Polyethylene oxide-based membranes resistant to solvent and heat are candidate for solid-solid shape stable phase change material in heat management. Polybutadiene-based membrane obtained from either free solvent electrospinning or aqueous suspension electrospinning are promising for water/oil separation.

The overall results demonstrate that the proposed approach (i.e., coupling of electrospinning and photo-induced crosslinking) is successful. Being sustainable and highly versatile by changing photo-crosslinking chemistry, it can be applied for the development of advanced membrane from various polymeric systems.