Production and characterization of thermoresponsive magnetic membranes

Adriana Gonçalves[1], Filipe Veiga Almeida[1], João Paulo Borges[1], Paula I. P. Soares[1]
[1]*Cenimat/i3N, FCT/UNL, Departamento de Ciência dos Materiais, FCT/UNL, Caparica, Portugal*

The present work focuses on the development of multifunctional devices with Fe_3O_4 magnetic nanoparticles and PNIPAAm microgels embedded in electrospun polymeric fibers for applications in magnetic hyperthermia and drug release. Fe_3O_4 nanoparticles with an average diameter of 8 nm were synthesized by chemical precipitation technique and later stabilized with dimercaptosuccinic acid (DMSA) and oleic acid (OA) [1]. PNIPAAm microgels were synthesized by surfactant-free emulsion polymerization (SFEP) [2]. At room temperature, PNIPAAm microgels are in a swollen state a with a hydrodynamic diameter of around 1 μm and above 32 ºC, the hydrodynamic diameter decreases and at higher temperatures the collapsed state of the microgels takes place, confirming their negative temperature response and Lower Critical Solution Temperature [3]. Poly(vinyl alcohol) (PVA) was used as fiber template and a fiber diameter of 179 ± 14 nm was obtained. 10 wt. % of PNIPAAm microgels and 8 and 10 wt. % of mNPs were incorporated in the PVA nanofibers through colloidal electrospinning in order to produce composite magnetic and thermosensitive membranes. Stress tests of the composite membranes show that the incorporation of microgels and nanoparticles in the electrospun membrane increases the Young's modulus and higher concentration of nanoparticles in the membrane also leads to an increase in this parameter. DMSA coated nanoparticles appear to have a slight impact in the rise of rigidity of the membrane when compared to the OA coated nanoparticles. Magnetic hyperthermia measurements show that a higher concentration of nanoparticles and a higher amount of membrane tested leads to a higher heating ability. The composite membrane with the most promising results is the highest amount of membrane with DMSA coated mNPs, since it shows the highest temperature variation, 5.1 ºC. If we consider a body temperature of 37 ºC, a temperature variation of 5.1 ºC is enough to reach the desired 42 ºC in magnetic hyperthermia treatment making this membrane a viable option in cancer treatment. Cytotoxicity assays were performed to evaluate the cytotoxic effect of PNIPAAm microgels and mNPs incorporated in PVA membranes. All assays reveal that PVA membranes incorporated with PNIPAAm microgels and mNPs do not present any type of cytotoxicity and can be used in biomedical applications. The present work demonstrated the potential of using multifunctional composite membranes for magnetic hyperthermia and may in future be used as an alternative treatment for cancer.

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[2] C. Echeverria *et al.*, "One-pot synthesis of dual-stimuli responsive hybrid PNIPAAm-chitosan microgels," *Mater. Des.*, vol. 86 (2015), pp. 745–751.
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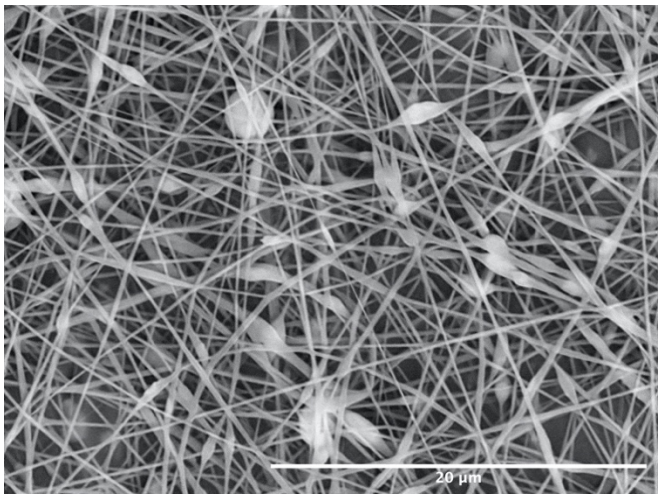

Figure 1: SEM image of PVA nanofibers incorporated with 10 wt. % PNIPAAm microgels and 8 wt.% OA coated mNPs