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Development of novel monophasic hybrid membranes for improved artificial kidney devices

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Hemodialysis (HD) is a clinically well-established membrane-based treatment for blood purification under extracorporeal blood circulation. Most of the hemodialyzers/artificial kidneys on the market are composed of synthetic polymer membranes with large pore sizes that allow the removal of uremic toxins (UTs) of large molecular weight. Nevertheless, these membranes are hydrophobic by nature and must be rendered hydrophilic before they can be used to filter blood toxins, thus adding an extra step in the preparation process. Even though they are able to remove many UTs from the blood of end stage renal disease (ESRD) patients, over 50% of known UTs remained untouched. Furthermore, they have been linked to the convective removal of useful and even vital compounds found in blood [1], [2].
Cellulose is a low-cost natural polymer and one of the most abundant renewable organic materials and cellulose acetate (CA) membranes are extensively used for their great mechanical flexibility, accurate chemical selectivity, and film-forming properties which allow the synthesis of membranes which cover a wide range of membranes processes, from ultrafiltration (UF) to reverse osmosis (OS). CA membranes also have great potential for artificial kidney devices, however disadvantages such as poor mechanical strength, low chemical resistance and thermal stability must be addressed. To overcome these limitations, we have developed monophasic hybrid cellulose acetate silica (CASiO2) membranes, with silica (SiO2) contents between 5 and 18 wt% by an innovative method which combines sol-gel and phase inversion techniques [1], [3].
The morphological and topographical characterization of the CASiO2 membranes was performed by scanning electron microscopy (SEM) and atomic force microscopy (AFM). Static contact angles were measured through the sessile drop method and permeation experiments were performed to determine the hydraulic permeability and rejection coefficients to reference solutes pertaining to the metabolic functions of the kidney [3].
SEM confirmed asymmetric membrane cross-section structures and AFM showed that the introduction of SiO2 reduced the submicron surface roughness when compared to the pure CA membrane. Contact angles revealed that the wettability increased for membranes containing high wt% of silica. Permeation studies show that the incorporation of SiO2 into CA membranes increased the hydraulic permeability of the CASiO2 membranes and that all hybrid membranes fully permeated urea and completely rejected albumin. Regarding the hemolysis assay, all CASiO2 membranes were non-hemolytic, low thrombogenic and did not promote the highest stages of platelet activation [3].

Scientific Area

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