LIGHT SWITCHABLE SURFACES

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ABSTRACT

Electrospun nanofibrous membranes have been developed that respond to changes in light. This research incorporates a photochromic spiropyran dye which can act as a molecular switch. The dye can reversibly isomerise between a hydrophobic ring-closed state and a hydrophilic ring-open state when exposed to light of the correct wavelength. The inclusion of such a molecule allows a membrane to be produced that can be reversibly switched between two stable states.

Poly(styrene-alt-maleic anhydride) is well known to react with primary amines. This knowledge was exploited by electrospinning the copolymer onto 2-hydroxy-1,3-diaminopropane producing a crosslinked nanofibrous membrane containing surface hydroxyl groups. These hydroxyl groups allowed further surface functionalization to take place. Various further surface modifications were explored, explained in more detail below.

A reversibly wettable surface (Fig. 1A) was created through the incorporation of the spiropyran onto the surface using known ester-coupling techniques. Contact angle measurements and attenuated total reflectance infrared (ATR-IR) confirmed the successful surface modification. Ultraviolet spectroscopy was also used to quantify the amount of spiropyran that reacted with the surface.The second approach involved grafting from the nanofibrous membrane using Activator Regenerated by Electron Transfer Atom Transfer Radical Polymerization (ARGET ATRP). This allowed surfaces to be modified without the necessity to rigorously remove oxygen by using an excess of reducing agent. ATRP initiator was attached to the membrane through a fraction of the hydroxyl groups present on the surface. A fluorinated compound was attached to the remaining hydroxyl groups to produce an extremely hydrophobic surface. Spiropyran incorporated monomer could be grown from the hydrophobic surface via the ATRP initiator sites producing a reversibly "sticky" surface (Fig. 1B). This implies that a water droplet would stick to the inclined surface in one state yet role off the inclined surface in another state.

Figure 1 – Investigated effects of light switchable surface polarity