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CO₂-Responsive Linen Surface Hydrophobicity

Alex Cormier,¹ Kyle Boniface,¹ Kaija Kaarid,¹ Michael F. Cunningham,^{2,*} Philip G. Jessop^{1,*}

¹Department of Chemistry, Queen's University, Kingston, ON, Canada, K7L 3N6

²Department of Chemical Engineering, Kingston, ON, Canada, K7K 3N6

*Corresponding author: Michael.cunningham@queensu.ca, Philip.jessop@chem.queensu.ca

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There have been many examples of “smart” or “switchable” materials in the literature that involve light,¹ pH,¹ temperature,² or redox stimuli³ that induce a chemical transformation or switch. The concept of pH responsive materials has then been further extended to use the benign, low cost CO₂. Most importantly, CO₂ does not accumulate in the system unlike traditional acid/base triggers in water.

Cellulose is the most abundant renewable raw material, other than CO₂, representing 1.5 x 10¹² tons of the total amount of biomass production, and is used in areas as diverse as composite materials, textiles, drug delivery systems, and personal care products.⁴ Cellulose is considered an inexhaustible resource as it originates from common feedstocks such as wood pulp, cotton, and flax, making it bio-renewable and sustainable. The effective utilization of these bio-renewable cellulose feedstocks would reduce the negative impact of chemical industries on the planet.⁵

This work explores the functionalization of cotton linen fibers using reversible deactivation radical polymerization (RDRP) to attach a CO₂-responsive hydrophobic polymer (Figure 1). Different polymer morphologies can be achieved on the linen surface that provide interesting hydrophobic properties. In addition, these “smart” surfaces can switch from hydrophobic to hydrophilic with the addition of carbonated water.

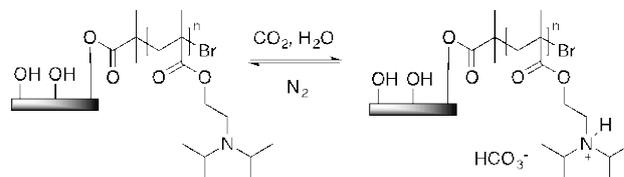


Figure 1. 2-(diisopropylamino)ethyl methacrylate grafted from the surface of cotton linen using RDRP and its CO₂-responsiveness.

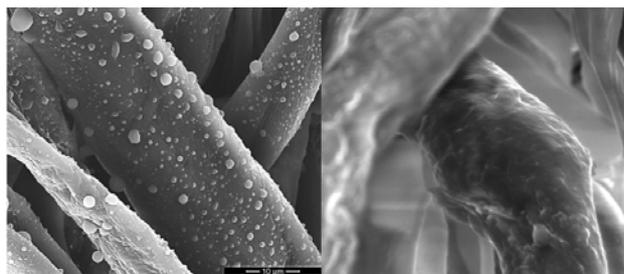


Figure 2. SEM image of polymer-grafted onto a linen fiber.

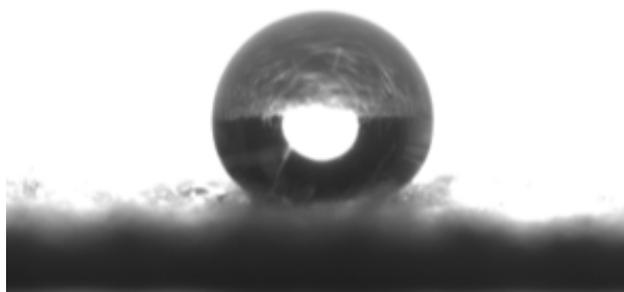


Figure 3. Water contact angle of hydrophobic linen.

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