Manipulating Polymers with Light Activated Chemistries for Patterning Films and Manufacturing Fibers

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Light activated chemistries are powerful for controlling the structure and function of polymers without the need for contacting the sample. Here recent research will be described from two projects where light is employed to enable new polymer processing capabilities. First, a new non-contact strategy for high-speed patterning of arbitrary shapes in polymer films will be described. In this approach, a topographical pattern can be preprogrammed and stored in a smooth solid film using light activated chemistry. The topography is later revealed without use of a wet or dry etch step, unlike traditional photoresist methods. The second project seeks to address the fact that fibers have been manufactured for decades using solvents or heat to reduce the viscosity of polymers and promote drawing. However, nature has engineered spiders and silkworms with benign ways of making silk fibers with high strength and toughness. Their approach of chemically linking small functional units into long chain molecules and solid fibrillar structures while simultaneously extruding the fibers is fundamentally different from current synthetic fiber manufacturing methods, where extrusion of pre-formed long chain polymers is facilitated with organic solvents or heat. Drawing inspiration from nature, a method will be described which uses light to trigger a thiol-ene chemical interaction to rapidly transform small reactive liquid mixtures into solid thread-like structures as they are forced out of a capillary at high speeds. Besides being manufactured without using solvents/volatile components or heat, these fibers are mechanically robust and have excellent chemical and thermal stability.