Scale-Up of the SLIP Process

A variety of applications require the use of nanoengineered surfaces for separation applications. The traditional approach of functionalization has two severe limitations: 1) the polymer used must be soluble; and 2) the solvent used must be removed from the final coating. The first limitation often eliminates many potential candidate polymers. The second limitation is influential on the transport and separation properties of the coating. These two issues can be overcome by the use of solventless vapor deposition followed by *in-situ* polymerization (SLIP).

Project Goals

Our goal was to create a roadmap for a scale-up of the SLIP process.

Relevance to LLNL Mission

A scaled-up SLIP process is critical to the growth of a membranes program within LLNL, providing vital resources to programs such as Energy and Environment, Defense and Nuclear Technologies, and NAI.

FY2005 Accomplishments and Results

The SLIP system is shown in Fig. 1. The SLIP process offers the capability to deposit and polymerize films of high-temperature polymers that are prepared using a condensation mechanism (as compared to a free radical type of polymerization). This includes high-temperature and high-performance polymers such as polyimides, nylons, polybenzimidazoles, and polybenzoxazoles.

Polyimide films that range in thickness from 50 to 400 nm were deposited onto a range of substrates. These substrates include polymers such as polycarbonate, Teflon AF, nylon, and silicone, as well as inorganics such as silicon wafers and glass. Excellent adhesion was observed in all cases.

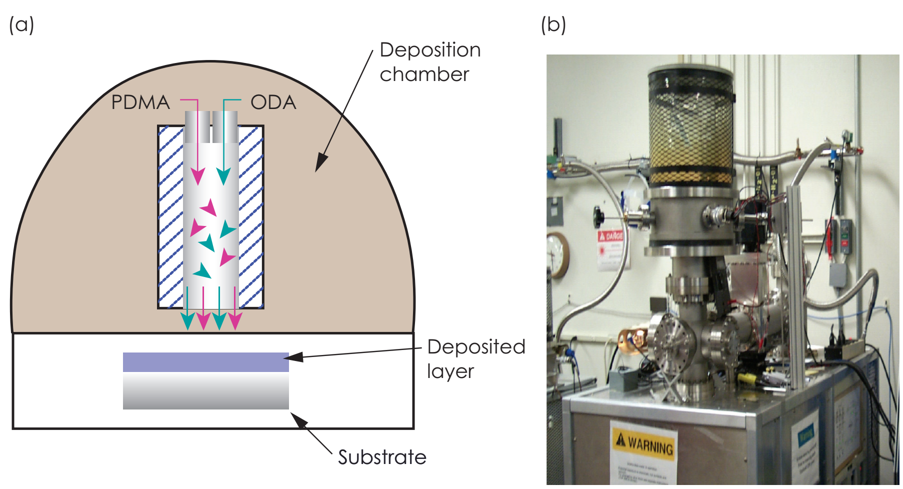

Figure 1. (a) Schematic of SLIP process; (b) photograph of benchtop SLIP deposition system.

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We also evaluated the economic viability of the SLIP process to determine whether the scaled-up process was economically attractive. Calculations were made using different values for parameters such as transit distance, width of web, and required thickness. Other factors that effect process economics are deposition pressure, and blocking, which refers to the ease of handling the coated web. Results show that the process is economically feasible at specified coating rates.

Based on our studies, we produced a preliminary configuration for a pilot-scaled SLIP coater (Fig. 2). An equipment vendor was identified and assisted in the production of a pilot-scale system that would be capable of coating fiber at a rate of approximately 200 km/day.

Risks can be reduced significantly by producing a prototype system that simulates the pilot scale system. We have created a prototype system that can be used to apply SLIP coatings to small-scale samples of fibers and films. This system was used to apply SLIP coatings to porous polypropylene substrates (see Fig. 3).

The SLIP process has been shown to be robust, and plans are in place to scale-up the process. This scale-up would enable the coating of flat sheets and fibers.

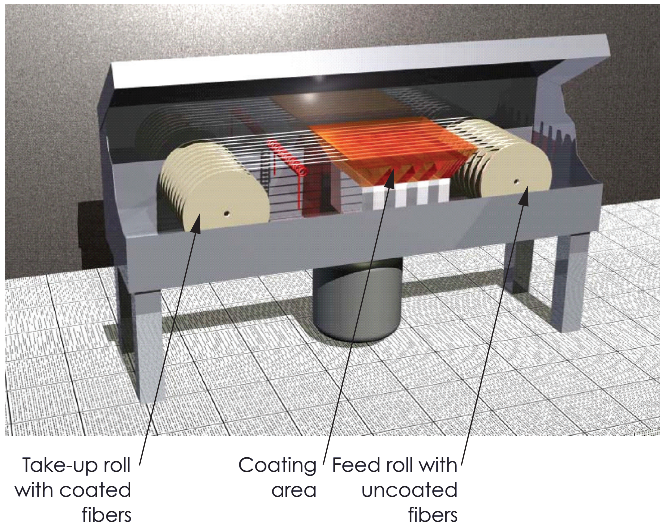

Figure 2. Preliminary configuration for pilot-scale SLIP coater. The system is shown with the top cover raised.

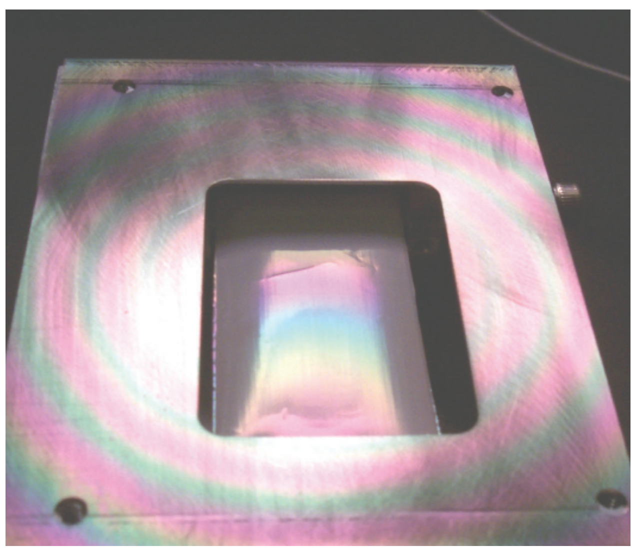

Figure 3. Close-up of coated substrate in prototype coater.

FY2006 Proposed Work

Future work involves additional tests using the prototype system. Once validated the pilot system will be constructed.