NANOSTRUCTURED THIN FILMS VIA LAYER BY LAYER ASSEMBLY AT THE INDUSTRIAL SCALE

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In the last two decades layer-by-layer (LbL) self-assembly has garnered significant interest as a simple, inexpensive and flexible technique for depositing nanostructured thin films with wide ranging applications from drug delivery to energy storage. The process involves the sequential adsorption of colloidal materials (i.e. nanoparticles, polyelectrolytes) with complementary intermolecular interactions (electrostatic, hydrogen bonding, antibody-antigen interactions) onto a surface. While this platform enables the LbL practitioner to select from a broad range of materials, precisely tailor the properties and morphology of the film and utilize an ambient environment, room temperature and environmentally friendly process, LbL has remained largely trapped in the laboratory because of limitations in commercially important parameters including size and throughput.

Our presentation will focus on Svaya's capabilities to scale the spray assisted LbL process from a bench scale prototype to an industrial scale in-line continuous roll-to-roll web process. We will highlight the capabilities and the corresponding resulting film properties which include precision, uniformity and conformality. Finally we will discuss current work in using these

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tools to create multilayer optical films for energy efficiency applications. By alternating TiO_2 nanoparticle-polymer layers with SiO_2 nanoparticle-polymer layers, we utilize constructive interference to create selectively reflective Bragg reflectors. We select the desired reflective wavelength ($\lambda_{o,R}$) and create standard quarter wavelength optical thickness (QWOT) reflector with individual layer thicknesess, $\lambda_{o,R} = nt/4$, where n is the refractive index and t is the physical thickness. When this interface is repeated, the reflectivity (R) is:

$$R = \left[\frac{n_0 (n_2)^{2N} - n_S (n_1)^{2N}}{n_0 (n_2)^{2N} + n_S (n_1)^{2N}} \right]^2$$

where n_0, n_1, n_2 *and* n_s are the refractive indices of the entering medium, two alternating materials and the exiting medium respectively and N are the number of material layer pairs. By increasing N, we increase the reflectivity. Figure 1 shows an example of the ability to create highly reflective Bragg reflectors with tunable $\lambda_{o,R}$.

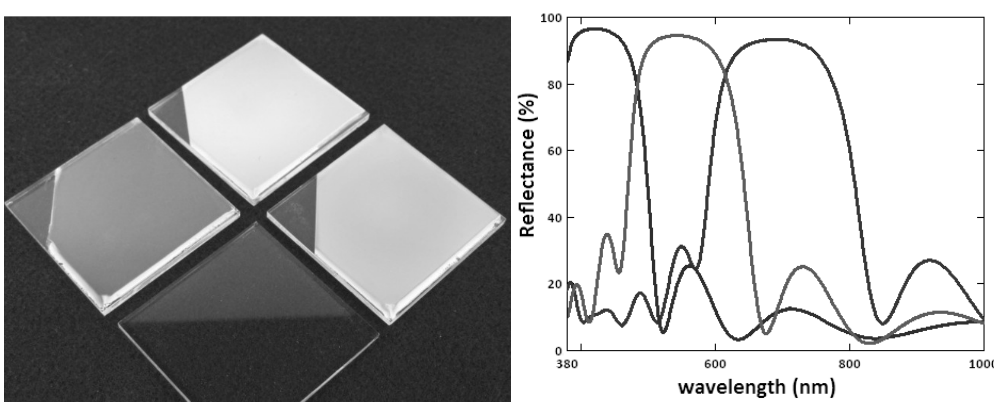

Figure 1. Selectively reflective Bragg reflectors on glass and corresponding reflectance curves (obtained form UV-Vis Spectrophotometry) demonstrating ability to select for $\lambda_{o,R}$.