

## **X-RAY REFLECTIVITY AND ATOMIC FORCE MICROSCOPY FOR CHARACTERIZATION OF COATINGS ON GLASS**

Scott T. Mixture

NYS College of Ceramics at Alfred University, Alfred NY 14802

Commercial thin film optical coatings on float glass were characterized using specular and diffuse x-ray reflectivity and atomic force microscopy. Low-emissivity coatings for thermal control containing up to five discrete thin films were investigated as complete film stacks and also as partial stacks where the specimens were coated with only 1-3 layers instead of five.

X-ray reflectivity was used to determine thickness, density, and interface roughness of each coating, while diffuse scattering was used to determine surface and subsurface interface roughness. Complete models of the reflectivity data provided the film characteristics from specular and transverse diffuse scattering. The x-ray measurements were made using a laboratory instrument and synchrotron radiation at the National Synchrotron Light Source.

Atomic force microscopy (AFM) was used to determine the surface roughness of the float glass and the top surfaces of the various film stacks. The coatings are typical of glass coatings and contain porosity, so the AFM was used to determine the pore size as well as to determine the roughness of the films between pores. Fractal models were used to model the XRR diffuse scattering and compared to the AFM results.

The data suggest that the diffuse scattering measurement is affected by the presence of porosity because the most applicable models of the XRR data require higher roughness than indicated by AFM. Nonetheless, the specular and diffuse data provide highly reliable thickness and density information, with reasonable, although imperfect, roughness values.

The paper demonstrates the applicability of AFM and x-ray reflectivity as complementary techniques for film characterization that can be used in a non-destructive fashion.