Co-GISAXS as a New Tool to Investigate Surface Growth Dynamics

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A detailed quantitative measurement of surface dynamics during thin film growth is a major experimental challenge. Recently we have used X-ray Photon Correlation Spectroscopy with coherent hard X-rays in a Grazing-Incidence Small-Angle X-ray Scattering (i.e. Co-GISAXS) geometry as a new tool to investigate nanoscale surface dynamics during sputter deposition of a-Si and a-WSi_2 thin films. For both films, kinetic roughening during surface growth reaches a dynamic steady state at late times in which the intensity autocorrelation function $g_2(q,t)$ becomes stationary. For the most surface-sensitive experimental conditions, the $g_2(q,t)$ functions exhibit compressed exponential behavior at all wavenumbers studied. The overall dynamics are complex, but the structure factor and correlation time exhibit power law behaviors consistent with dynamical scaling [1]. Simulations were performed to better compare the observed kinetics with predictions of linear and nonlinear growth models.

In contrast to the simple compressed exponential relaxation of $g_2(q,t)$ observed under surface-sensitive experimental conditions, more complex behavior is seen under conditions in which the X-ray signal comes from both the growth surface and the thin film bulk. In this case, oscillations in temporal correlations arise from coherent interference between scattering from stationary bulk features and from the advancing surface. We observe evidence that elongated bulk features propagate upward at the same velocity as the surface [2].

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References

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