

X-ray Photon Correlation Spectroscopy Studies of Equilibrium and Non-Equilibrium Dynamics in Materials

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The greatly increased brightness of synchrotron hard X-ray sources has enabled a new set of experimental methods using coherent X-ray beams. One of these, X-ray photon correlation spectroscopy (XPCS), is sensitive to structural dynamics on length scales down to the atomic scale. Using a coherent beam, one can resolve the speckle pattern in diffuse X-ray scattering from disordered structures. This speckle is sensitive to the exact arrangement of the disorder, not just its average properties. The time dependence of the speckle thus reveals dynamics and correlations not visible without a coherent beam. We will illustrate the technique with results from three recent studies of dynamics in materials: equilibrium critical fluctuations in a complex liquid [1], steady-state surface island nucleation during layer-by-layer crystal growth [2], and driven domain switching in a ferroelectric thin film. Continuing upgrades to synchrotron sources promise to make XPCS studies possible for an ever-widening range of materials processes.

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