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**Probing Nanoscale Structure and Dynamics in Polymer Nanocomposites by SAXS and XPCS.** R. Aravinda Narayanan<sup>1,3</sup>, S. Lewis<sup>4</sup>, A. Bansal<sup>5</sup>, L.S. Schadler<sup>4</sup>, L.B. Lurio<sup>6</sup>, S. Narayanan<sup>2</sup>, P. Thiyagarajan<sup>1</sup>, <sup>1</sup>IPNS, <sup>2</sup>APS, Argonne National Lab, Argonne, IL, <sup>3</sup>Oak Ridge National Lab, Oak Ridge, TN., <sup>4</sup>Rensselaer Polytechnic Inst., Troy, NY., <sup>5</sup>GE Global Research, Niskayuna, NY., <sup>6</sup>Northern Illinois Univ., DeKalb, IL.

Polymer nanocomposites exhibit radically different thermo-mechanical properties which are, generally, attributed to the larger interfacial area of the nanoparticle which increases the polymer-filler interactions; and the nanoscale confinement of the polymer by nanoparticles leading to changes in the polymer dynamics. Our SAXS studies reveal the presence of hierarchical particle structures that varies with the particle surface chemical treatment, which is performed to tune the polymer-particle interactions. Using XPCS we show for the first time that the internal stress at the interface due to the presence of nanoparticles could be measured. It is found that the internal stress, which arises due to the entropic penalty that the polymer faces in the presence of the nanoparticles, engenders heterogeneous dynamics: The faster relaxation modes are significantly affected by the interface and are uniquely related to the bulk properties. Using SAXS and XPCS we attempt to provide a general framework for understanding the relationship between the nature of the interfaces and thermo-mechanical properties.

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