ADDRESSING CHALLENGES IN MATERIALS ENGINEERING AND BIOTECHNOLOGY THROUGH COMBINED SAXS AND SANS MEASUREMENTS.

There have been important advances in the small-angle X-ray and small-angle neutron scattering (SAXS and SANS) methods in recent years. Measurements using these techniques now contribute significantly towards addressing the complex challenges associated with a wide range of materials of technological importance. Many examples of current interest exist that demonstrate how SAXS and SANS can extract statistically representative microstructure information (e.g., void or particle volume fraction size distributions, internal surface areas, pore or particle ensemble morphologies) that complements the information obtained from diffraction methods, X-ray microtomography, or electron microscopy.

By combining SAXS and SANS methods, deeper insights can be gained into the processing–microstructure–property relationships that frequently govern technological performance. For example: although Portland cement concrete is the world's most widely used manufactured material, basic questions persist regarding its internal structure and water content, and their effect on concrete behavior. By combining SAXS and SANS data, it has been possible, for the first time without recourse to drying methods, to measure the composition and solid density of the principal binding reaction product of cement hydration, calcium–silicate–hydrate (C–S–H) gel which is, itself, one of the most complex of all gels.

In a range of industries including biotechnology and medicine, solution-mediated reaction routes are increasingly exploited for the formation of non-agglomerated and mono-dispersed nanoparticle systems. To gain insights into such processes, SAXS and SANS can provide representative and quantitative microstructure characterization, for example, of a nucleating solid phase from solution. In this context, SAXS can accommodate fast time resolution and small sample volume; SANS can exploit the strong neutron contrast isotope effect to establish the distribution of hydrated phases in and around such nanoparticles.

These and other examples will be presented and discussed to demonstrate the impact of combined X-ray an neutron scattering methods .

References:

A.J. Allen, J.J. Thomas and H.M. Jennings; "Composition and Density of Nanoscale Calcium–Silicate–Hydrate in Cement," Nature Mater., **6**, 311-316 (2007).

A.J. Allen; "Characterization of Ceramics by X-ray and Neutron Small-Angle Scattering," J. Am. Ceram. Soc., **88**, 1367-1381 (2005).