It’s a Small World: Applications of Advanced SAXS

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Your material is beautiful on every level; practically, macro- and microscopically. For systematic, intelligent materials development, though, reliable structural parameters are indispensable. With microscopic techniques inherently limited to observing microscopic volumes, another type of technique is required for proper, bulk-scale nanostructural quantification. Theoretically, small angle scattering can fill this space: it can characterise the nanostructure of large amounts of material with a minimum of fuss. Practically, however, one of the biggest stumbling blocks in its application is the data correction and analysis, in particular for polydisperse systems.

Attempts at describing scattering behaviour using common, “classical” fitting methods often end in frustration and/or give unreliable or overly broad results. In trying to alleviate these issues (and make small-angle scattering more accessible), an advanced, comprehensive small-angle X-ray scattering (SAXS) methodology has been developed for authoritative quantification of materials nanostructure. This approach has been three-pronged: 1) improving the measurement collection, correction and analysis, 2) application and fine-tuning of the advanced methods to practically relevant samples, and 3) drastically extending the measurement range through novel instrument design and optimization.

Now, given high-quality data [1] and information on the basic shape of the nanostructural morphology, a form-free size distribution can be determined complete with uncertainty estimates [2]. After a brief introduction to scattering, the practical applicability of these advanced methods will be exemplified in this talk. Examples will be given for (amongst others) precipitation in metal alloys [3], novel, gelatin-derived catalyst materials [4], and anisotropic, aligned (pore) structures in fibres [5] (Figure 1).

Figure 1: Overview of several advanced SAXS applications. From left to right: Anisotropic pattern fitting, ORR Catalyst characterization, Mg-Zn alloy characterisation, Early prototype Ultra-SAXS results.