Detection, quantification and derivation of number size distribution of silver nanoparticles in antimicrobial consumer products

Abstract:
In 2011 the European Commission published its recommendation for a definition for the term nanomaterial which requires the materials to be characterized in terms of the number size distribution of their constituent particles. More recently, the definition has begun to be applied to the labelling of food and cosmetic products where any components present in the form of engineered nanomaterials must now be clearly indicated in the list of ingredients. The implementation of this definition requires that methods be developed and validated to accurately size particles with at least one external dimension in the range of 1-100nm, and to quantify them on a ‘number-based’ particle size distribution. An in-house developed method based on Asymmetric Flow Field Flow Fractionation–Inductively Coupled Plasma Mass Spectrometry (AF4-ICP-MS) for the simultaneous detection and quantification of citrate-stabilised silver nanoparticles (AgNPs) in water, has been applied to real-world liquid antimicrobial consumer products based on colloidal silver. This transfer of the method from ideal model systems to real products was assessed in light of other techniques including Centrifugal Liquid Sedimentation (CLS), Dynamic Light Scattering (DLS) and Transmission Electron microscopy (TEM). Five out of six analysed products were found to contain AgNPs in the nano-range by mean of a number of techniques including AF4-ICP-MS. Comparative analysis shows that CLS has sufficient size resolution to size AgNPs in the consumer products while DLS was unsuccessful probably due to sample polydispersivity. Despite the silver nanoparticles having unknown surface properties and stabilisation agents which could have influenced the sizing with AF4, a relatively good agreement between TEM and AF4-ICP-MS was observed. The AF4-ICP-MS data could be converted from mass-based to number-based distributions; this transformation, despite the possibility of experimental artefacts being mathematically amplified, has shown promising results.

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