Relative nanoparticle concentration with benchtop methods

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As nanomaterials become routine additions in many consumer products and with the advent of emerging regulations around their incorporation into such products, significant effort has led to the development of a suite of metrological infrastructure for accurate measurement of particle size, including instrumentation, documentary standards and reference materials. Despite this, equivalent developments relating to the measurement of number concentration of particles in liquid suspension have not advanced at the same pace. Given the reliance of both regulations and many toxicological studies on particle number concentration, this gap needs to be rapidly addressed [1].

Currently, there are no certified reference materials available that are specifically designed for measurements of nanoparticle number concentration. However, a number of single-particle techniques conventionally used for particle size distribution analysis also claim to measure particle number concentration. These include particle tracking analysis (PTA) and resonant mass measurement (RMM).

In this study, we use size-monodisperse gold nanoparticles and specifically prepared bi-modal distributions of such particles to create dilution series for investigating nanoparticle concentration. Measurements of the particle number concentration by PTA and RMM are compared with the expected concentration, converted from mass-concentration values. Both supplier specifications and the mass-concentration determined by inductively coupled plasma mass spectrometry (ICP-MS) are used to determine the expected number concentration, in conjunction with the certified particle size. The number concentrations obtained using single-particle techniques are also compared to the expected number concentrations obtained by ensemble techniques, such as differential centrifugal sedimentation. Finally, the relative uncertainties in the measurement of particle number concentration are considered.

1. Linsinger, T.P.J., et al., "Requirements on measurements for the implementation of the European Commission definition of the term 'nanomaterial'", European Commission, Joint Research Centre, 2012.