Field Flow Fractionation Coupled with Light Scattering and ICP-MS for Quantitative Bio-Nano Measurements

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An instrumental platform based on asymmetric flow field flow fractionation (AFFF) coupled with classical multi angle light scattering (MALS), dynamic light scattering (DLS) and ICP-MS was established and applied to the study of silver, gold and selenium NPs in biological materials.

Using the platform, gold nanoparticles (10-60 nm o.d.) were separated and quantified with respect to their size and mass concentration (Fig. 1), and figures of merit including LOD, recovery and repeatability were established [1]. The bare gold NPs adhered to instrument surfaces, as demonstrated by electron microscopy, and caused incomplete recoveries. Gold NPs were administered by intravenous injection and recovered from rats' livers following alkaline solubilisation of the tissue. The gold NPs were successfully stabilised with bovine serum albumin (BSA) in the alkaline suspension, but TEM imaging showed that the NPs were associated with un-digested tissue residues, which precluded appropriate separation by AFFF.

The platform was used to the study absorption, distribution, metabolism and excretion (ADME) in rats of BSA-stabilised Se^0 NPs (20 nm o.d.) using selenite as positive control. The results (Fig. 2) showed that selenium as nano-Se^0 particles or as selenite both were highly bio-available and mainly were deposited in liver and kidney or excreted via urine and feces. Se^0 was detected in tissues of rats following *in situ* reaction with sulphite to form the selenosulfate anion, which was determined by HPLC-ICP-MS. The finding of Se^0 both in tissues from nano- Se^0 and selenite dosed animals brings new information to the current knowledge about metabolic pathways of selenium.

Research on dedicated methods for sample preparation of food prior to silver NP detection is underway in the NanoLyse project, funded by the European Commission (www.nanolyse.eu)

The general conclusion of our work on biological research with nanoparticles is that access to a variety of tools and methods, including appropriate sample preparation, separation and atomic spectrometric detection and electron microscopy, are necessary for trouble shooting and acquisition of robust data.

References

[1] Bjørn Schmidt[a,b], Katrin Loeschner[b], Niels Hadrup[b], Alicja Mortensen[b], Jens J. Sloth[b], Christian Bender Koch[a] and Erik H. Larsen[b*], Quantitative Characterization of Gold Nanoparticles by Field-Flow Fractionation Coupled On-line with Light Scattering Detection and Inductively Coupled Plasma Mass Spectrometry, Anal. Chem., (submitted)

Fig.1 AFFF-LS-ICP-MS fractogram and hydrodynamic diameter of a mixture of 4 gold nanoparticles

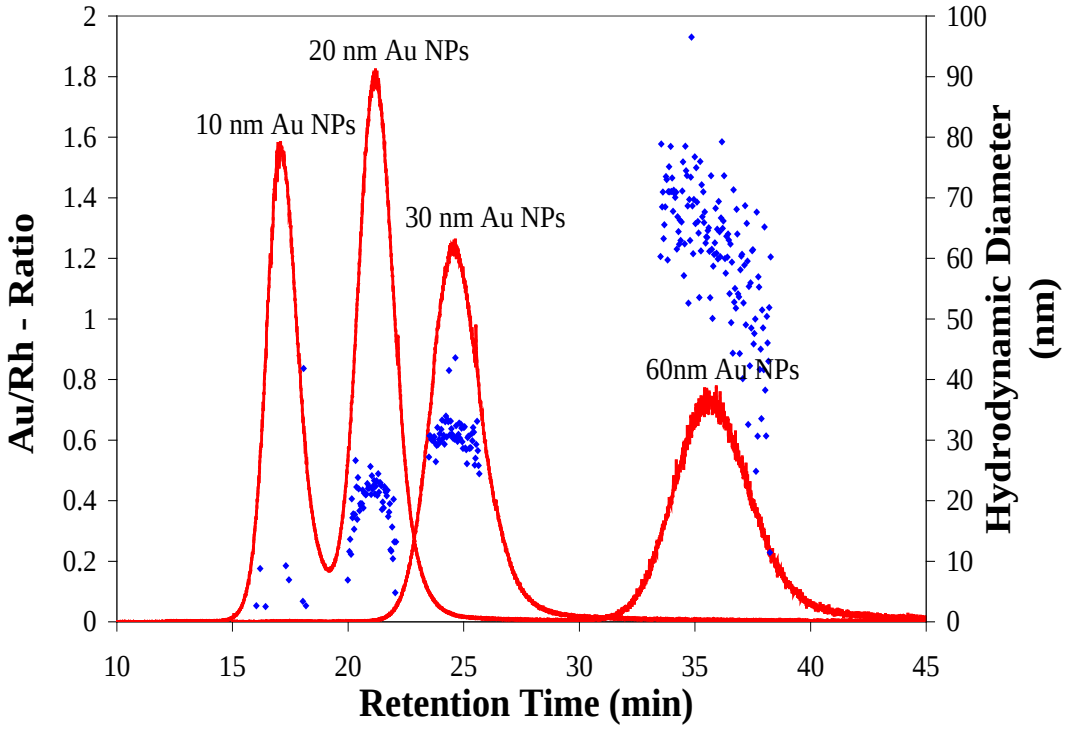

Fig 2. Distribution of selenium in biological samples from rats administered selenium at 0.4 mg/kg b.w./day for 28 days as BSA-stabilised nano-Se^0 or selenite