

Mn in welding fume: Characterization and exposure biomarkers

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The association between exposure to airborne Mn and neurotoxic outcomes is well understood. However, the association between airborne Mn exposure and Mn uptake from the pulmonary system remains unclear. Toxicological research indicates that the chemical and physical form of Mn in exposures are determinants of the time course of Mn uptake.

Welding fume was selected as the source of Mn inhalation exposure. The goal of this human exposure assessment study was to: 1) fully characterize the weld fume, and 2) identify the time course of uptake and clearance of metals in the pulmonary system following inhalation exposure. Scanning transmission electron microscopy spectrum imaging, employing energy-dispersive X-ray spectroscopy and electron energy-loss spectroscopy, was used to determine the size and composition of fume nanoparticles. Mn in exhaled breath condensate (EBC) and blood Mn were selected as biomarkers of exposure. Two measures of exposure were developed and characterized for incorporation in the study: primary particle count median diameter (CMD) and Mn composition by size. In addition, a method for the collection and analysis of EBC was characterized and incorporated in study measures.

The average Mn concentration in welding fume was 375 $\mu\text{g}/\text{m}^3$ (range 8-1800 $\mu\text{g}/\text{m}^3$). Fume nanoparticles crystallized with the spinel structure (hausmannite and magnetite). The average primary particle CMD was 6.9 nm (range 3.2-14.5 nm). There was an overall positive correlation between Mn content and particle size. In addition, the smallest size fraction (<10 nm) exhibited a lowering of Mn content consistent with a 'self cleansing' mechanism observed in semiconductor materials. The average mean valence state of Mn was +2.15.

No trend in uptake of Mn due to welding was measured in blood. Nine exposed subjects had a significant EBC Mn peak concentration following welding. Among subjects with an EBC-Mn peak, the primary particle CMD and the Mn composition by particle size slope were associated with the timing and concentration level of the maximum EBC Mn peak. Our findings suggest that an understanding of the particle size and composition is important when characterizing the impact of inhalation exposure to Mn.

New strategies for precise & accurate isotope ratio determination from very small analyte quantities using the NEPTUNE Plus MC-ICP-MS

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The Thermo Scientific NEPTUNE Plus with Jet Interface offers unparalleled MC-ICP-MS sensitivity for heavy isotopes. An ion yield of c. 4% has previously been reported for uranium [1]. Sensitivity enhancements have been achieved through a combination of a dry high-capacity (100 m^3/h) interface pump, X-cone, Jet cone, and the Cetac Aridus II desolvating nebuliser system.

The sensitivity of the Jet Interface for small spot size (< 10 μm diameter) LA-MC-ICP-MS was trialled for natural uraninite, NBL U030 & U500 certified reference materials, using a New Wave Research UP-213 laser ablation system.

For applications where very small absolute quantities of analyte are available in solution, improved sample introduction strategies are desirable. For example, in nuclear forensics, 1 – 2 μm diameter uranium oxide particles comprise less than 40 pg of total uranium. Traditionally these are analysed using TIMS. MC-ICP-MS offers greater productivity, and large datasets can yield more information [2]. This analytically challenging application is used to illustrate new capabilities for isotope ratio measurement from very small analyte quantities.

A combination of ESI SC-2 DX microFAST injection autosampler, Apex IR FAST nebuliser and SpiroX heated membrane desolvator were trialled as a sample introduction system for MC-ICP-MS. This combination allows the automated rapid injection of solution micro-samples. Reagent blank levels can be minimised and wash-out is rapid. The efficiency of sample introduction is significantly increased, and therefore the signal to noise ratio is improved.

[1] Bouman *et al.* (2009) *Geochim. Cosmochim. Acta.* **73**(13, Supplement 1). [2] Lloyd *et al.* (2009) *J. Anal. At. Spectrom.* **24**(6), 752–758.