Elemental Scientific LASERS
INNOVATION TO ILLUMINATE

Poster Note

Authors: Robert. W. Hutchinson[1], Timothy H. Marczylo[2], James L. Warren[2]

Studies of iridium nanoparticle Translocation in rat organs using LA-ICP-MS

Introduction

Nanomaterials – particles with an external dimension in the size range of 1-100 nm – exhibit distinct properties due to increased surface area and consequential increased reactivity and/or conductivity. Nanomaterials have been incorporated extensively into consumer products including those related to health and fitness (personal care products, clothing, cosmetics, sports goods, filters and sunscreen), home and garden, food and beverages (to change texture, enhance flavour, reduce fat content, etc.), motor vehicles, electronics and appliances. Commonly used nanomaterials in consumer products are nanoscale Ag, Ti/TiO_2, C (nanotubes, nanofibers, fullerenes), SiO_2, Zn/ZnO and Au, and use of CeO_2 nanoparticles as a diesel fuel additive to improve performance and emissions is increasing, resulting in increasing exposure to these agents.

The altered physicochemical properties of elements in nano form may affect their toxicity. In particular there is concern that inhaled nanoparticles, especially those that are fibre-like, may have toxicity similar to that of asbestos which has fibres in the 3-20 µm range (and possibly slim fibres in the <60 nm range) and is responsible for asbestosis and mesothelioma. Advances in nanotechnology have raced ahead of toxicological investigations and therefore little is known about the toxicity of nanomaterials. As such investigations of deposition, persistence, distribution and toxicity of nanomaterials especially by the inhalation route are key to understanding the risk to health of nanomaterials. Of particular interest is whether nanomaterials translocate from the lung to other tissues where they may be responsible for as yet uninvestigated toxicity and whether this is dependent upon size.

1. Electro Scientific Industries, Ltd. 8 Avro Court, Huntingdon, PE29 6XS, UK
2. Centre for Radiation, Chemical and Environmental Hazards, Public Health England, Chilton, Oxfordshire, OX11 0RQ, United Kingdom

Experimental

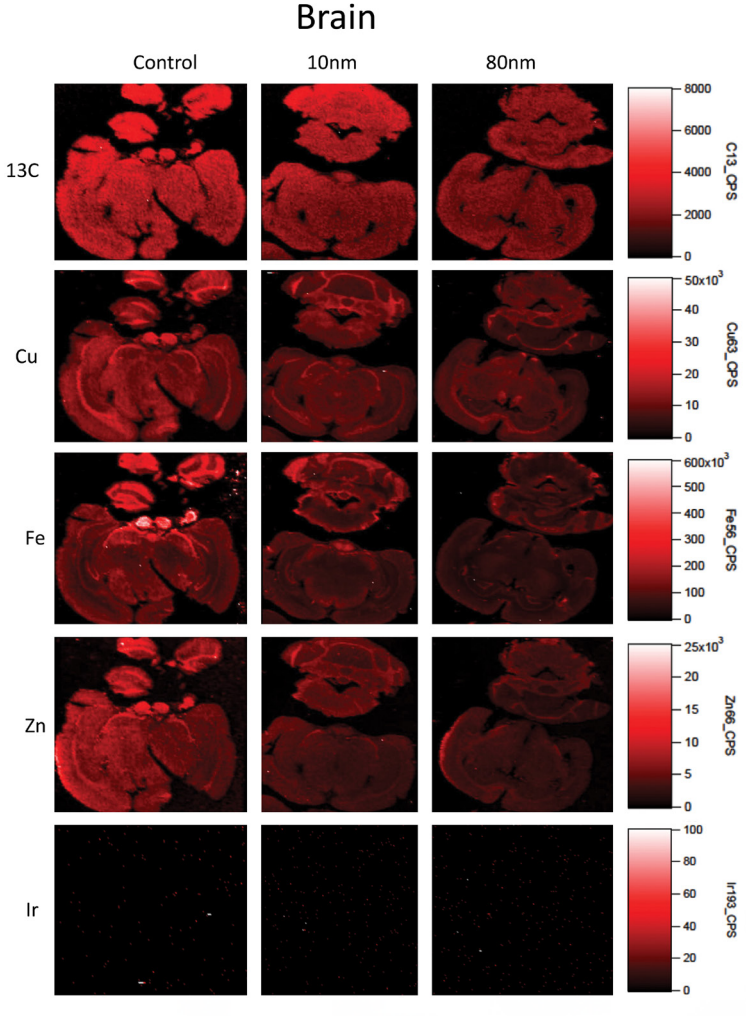
Rats were exposed to either 10 nm (9.7±0.1nm; 1.4µg; 2.90e11 particles) or 80 nm (76.3±1.9nm; 37µg; 5.75e10 particles) spark generated iridium nanoparticles aerosol in argon, humidified and diluted in O_2 and N_2 to ambient concentrations, by the nose only route, while control rats were not exposed. Animals were sacrificed 30 days post exposure and the brain, kidney and liver were formalin fixed and paraffin embedded. Sections (4 µm) were obtained using a cryomicrotome, mounted onto glass slides and de-waxed.

Imaging was performed using a NWR213 (now ESL213) laser ablation system (Elemental Scientific) and an iCAP Q ICPMS (Thermo Scientific). Key parameters are shown in Table 1. Data was reduced using Iolite.

Parameters Employed

Laser Ablation	NWR213
Spot Size	100 µm
Repetition Rate	20 Hz
Scan Rate	450 µm/s
Fluence	5 J/cm^2
He Flow Rate	0.70 mL/min
ICPMS	**Thermo iCAP Q**
RF Power	1300 W
Neb Ar Flow Rate	0.69 mL/min
Isotopes Monitored	13, 56, 63, 66, 193

Table 1. Data was reduced using Iolite.



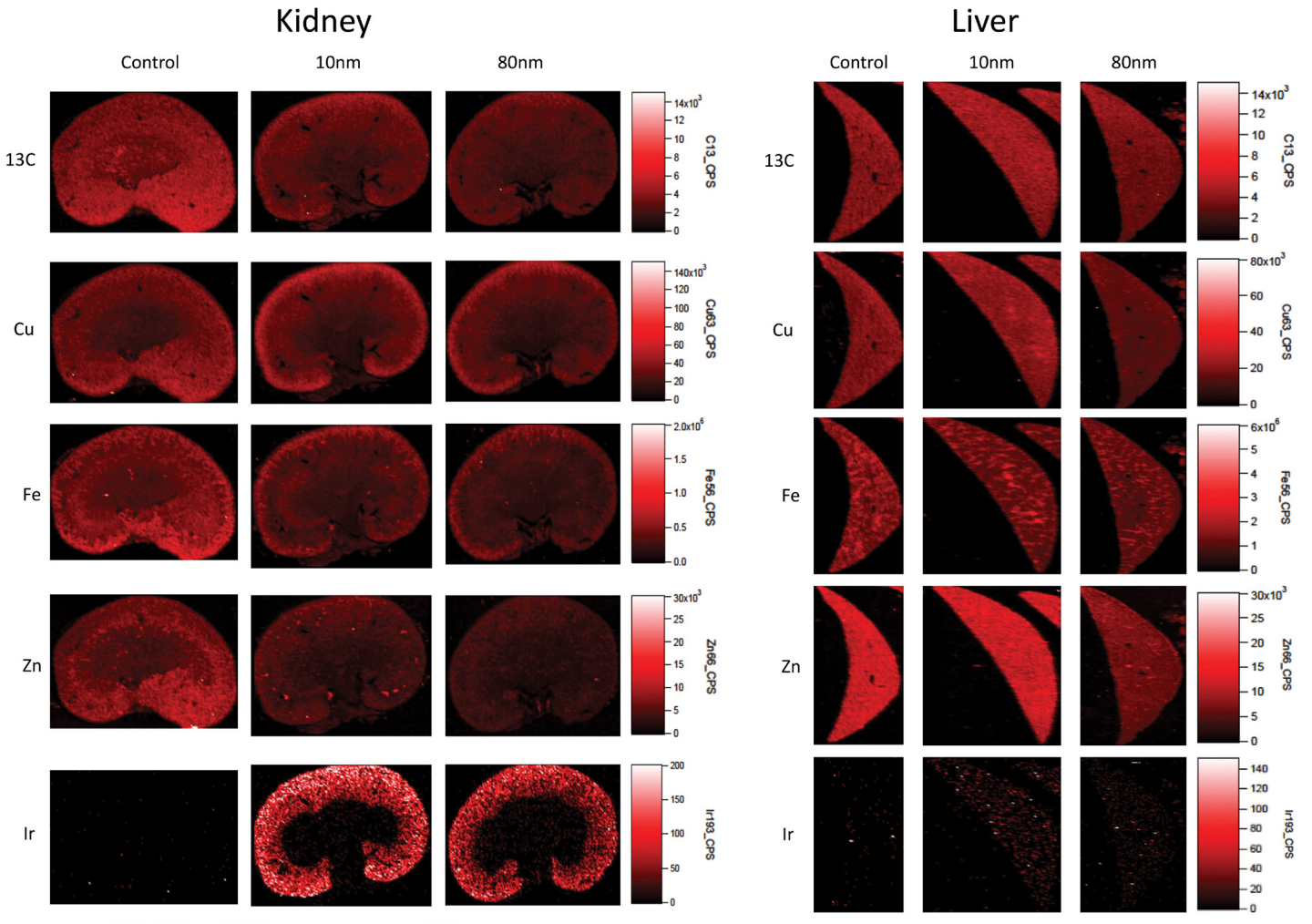


Figure 1. 2-dimensional elemental images of rat brain, kidney and liver tissue sections. Three key samples shown are from a control animal, and animals exposed to 10 nm and 80 nm nebulized and inhaled Ir particles.

Results

Figure 1 shows the results of the imaging experiments in brain, kidney and liver. There is evidence of Ir having passed from the lung into the kidney and liver. There is no evidence of Ir having crossed the blood-brain barrier. In kidney, iridium is located primarily in the cortex. There is a suggestion that the smaller (10 nm) more readily translocate to the kidney and liver than the larger (80 nm) nanoparticles but this needs verification with replicates.

Conclusions

Laser ablation ICPMS is a fit-for-purpose tool for researching the biological fate of nanoparticles in studies of exposure. Further work will extend the range of nanoparticle composition, particle size and exposure times.

Elemental Scientific LASERS

© Elemental Scientific Lasers LLC | 685 Old Buffalo Trail | Bozeman, MT 59715
Tel: 406-586-3159 | lasers@icpms.com | www.icpmslasers.com

18011UP