

## Changes in metal nanoparticle shape and size induced by swift heavy-ion irradiation

M.C. Ridgway<sup>1</sup>, P. Kluth<sup>1</sup>, R. Giulian<sup>1</sup>, D.J. Sprouster<sup>1</sup>, L.L. Araujo<sup>1</sup>, C.S. Schnohr<sup>1</sup>, D.J. Llewellyn<sup>1</sup>, A.P. Byrne<sup>1</sup>, G.J. Foran<sup>2</sup> and D.J. Cookson<sup>3</sup>,

<sup>1</sup>*Research School of Physical Sciences and Engineering, Australian National University, Canberra, Australia;* <sup>2</sup>*Australian Nuclear Science and Technology Organisation, Menai, Australia;* <sup>3</sup>*Australian Synchrotron, Melbourne, Australia.*

Using a combination of transmission electron microscopy, small-angle x-ray scattering and x-ray absorption spectroscopy, we have characterised shape and size changes in metal nanoparticles induced by swift heavy-ion irradiation (SHII). Elemental Co, Pt and Au nanoparticles of diameters 2-15 nm were formed in amorphous SiO<sub>2</sub> by ion implantation and thermal annealing. Samples were then irradiated at room temperature with 27-185 MeV Au ions as a function of ion fluence. Our primary results include:

- (i) Spherical nanoparticles below a minimum diameter (4-7 nm) remain spherical under SHII. They increase in size initially but then decrease as a result of a progressive dissolution into the SiO<sub>2</sub> matrix.
- (ii) Spherical nanoparticles beyond the minimum diameter are converted to elongated rods aligned with the ion beam direction for each of the three metals.
- (iii) For a given ion fluence, the change in shape is more efficient as the electronic stopping power increases.
- (iv) The width of the elongated rods saturates at an electronic-stopping-power dependent value, progressively increasing from 4 nm (at 5 keV/nm) to 7 nm (at 18 keV/nm). This saturation value is well correlated with the diameter of the molten track induced by SHII.
- (v) The length of the elongated rods exhibits a broad distribution consistent with that of the unirradiated spherical nanoparticles. Aspect ratios as high as ~20 were apparent.

In summary, we have combined laboratory- and synchrotron-based techniques to demonstrate changes in shape and size are primarily governed by the SHII parameters not the metal nanoparticle properties.