ESRF	**Experiment title:** Magnetic Circular Dichroism Study of Mass-Selected Nanoscale Fe Clusters	**Experiment number:** HE 232
Beamline: ID12B	**Date of experiment:** from: 5/12/97 to: 18/12/97	**Date of report:**
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Report:

X-ray magnetic circular dichroism (XMCD) was used to study exposed nanoscale Fe clusters deposited *in situ* using a portable UHV-compatible gas aggregation source capable of cleanly depositing size-selected transition metal clusters in the size range 1 - 5 nm (40 - 5000 atoms). The morphology of the clusters was determined in a previous *in situ* STM study [l]. XMCD is a very sensitive technique able to resolve the orbital and spin moments in a magnetic material. The aim was to measure the moments as a function of cluster size and density and to see if well-separated, exposed, clusters on a surface have enhanced magnetic moments as found in free [2] and embedded [3] clusters.

The particles were deposited onto graphite (HOPG) substrates held at a temperature of 10 K and between the poles of a superconducting magnet. X-ray absorption spectra of the Fe L edge were taken for parallel and anti-parallel alignment of the photon spin and the magnetic field (2T) applied normal to the sample surface. Four un-filtered cluster assemblies (log-normal size distribution peaking at 2 nm) and one mass-filtered sample (2.2 nm or 800 atoms) were studied. The un-filtered clusters landed with thermal energy whereas the mass-filtered ions had a kinetic energy of about 20eV. Throughout the experiment no trace of oxide contamination was observed.

Figure 1 summarises the results. The open squares and circles are the orbital (m_l) and spin+dipole ($m_l + 7m_T$) magnetic moments, respectively, obtained for un-filtered cluster depositions at different coverages; the filled characters are for the mass-selected sample. The coverage is expressed as the-equivalent thickness of a continuous film; a dense

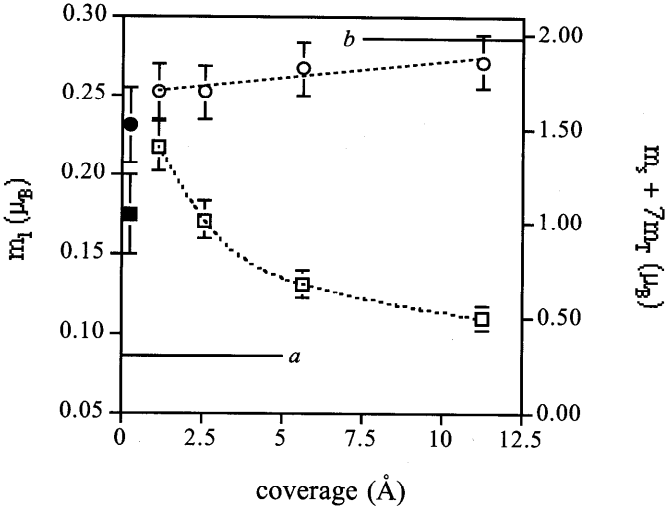

Figure 1

monolayer of clusters corresponds to a thickness of 17Å. In the lowest coverage film (1.1 A - average cluster separation = 120 A) the magnitude of m, is a factor of two higher than the bulk value but drops towards the bulk value as the density increases. The enhanced orbital moment is due to the high proportion of atoms (15% - 50%) on the cluster surfaces which experience an asymmetric crystal field. The decrease in the orbital moment with coverage is a result of the increase in the average atomic co-ordination as the clusters come into contact. The small increase in the $m_s + 7m_T$ term with coverage is due to a decrease in the dipole contribution (opposite in direction to the spin) as the average atomic co-ordination increases.

The mass-filtered cluster assembly shows a decrease in the $m_s + 7m_T$ term which we ascribe to an increase in the dipole moment due to the higher impact energy of the ions producing a greater distortion on impact with the surface. This is the first demonstration of a change in the magnetic properties as a result of changing the deposition energy of clusters.

The work has been submitted to Physical Review Letters [4]. A new source delivering twenty times more flux and able to deposit measurable mass-selected samples with a mass resolution of 1% has been developed. We will apply for beam time on ID12B to use it in a study the magnetic moments as a function of cluster size.

References

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