| ESRF | **Experiment title:** MXCD Study of Exposed, Mass-Selected Fe Clusters Deposited in situ | **Experiment number:** SI-456 |
|---|---|---|
| **Beamline:** ID12B | **Date of experiment:** from: 25/5/1999 to: 18/6/1999 | **Date of report:** 24/2/2000 |
| **Shifts:** 30 | **Local contact(s):** Dr. N. B. Brookes | *Received at ESRF:* 28 FEV. 2000 |

**Names and affiliations of applicants** (* indicates experimentalists):

*Dr. C. Binns
*Prof. C. Norris

Department of Physics and Astronomy, University of Leicester, Leicester LE1 7RH, UK

**Report:**

The experiment studied the orbital and spin magnetic moments, Using MXCD in size-selected Fe nanoclusters, exposed in UHV and with a Co cap deposited *in situ*. The run was highly successful and resulted in two submitted papers, the abstract and most significant results of each are presented below.

**Paper 1**

*Size dependence of the magnetic moments of exposed nanoscale iron particles*
K.W. Edmonds, C. Binns, S.H. Baker, M.J. Maher, S.C. Thornton, O. Tjernberg, N.B. Brookes, submitted to Phys. Rev. Lett., 16th December 1999.

**Abstract**

The magnetic moments in exposed, mass-selected, nanoscale Fe clusters in the size range 1.89-2.20 nm (300-475 atoms), deposited onto graphite *in-situ* have been measured by X-ray magnetic circular dichroism (XMCD) The smallest clusters possess moments that are enhanced by around 4% for $m_{spin}$ and 80% for $m_{orb}$ and decrease towards the bulk value with increasing size. The saturated moments are temperature dependent due to *intra-particle* magnetic disorder. The larger clusters show an in-plane anisotropy that is consistent with the anisotropy in the orbital moment. The smallest clusters are, within experimental error, magnetically isotropic. The anisotropy constant is 10 times higher

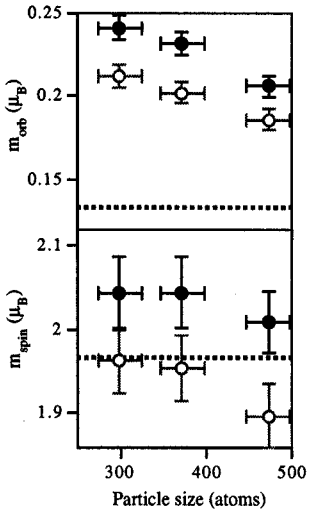
than the bulk value.

## Paper 2

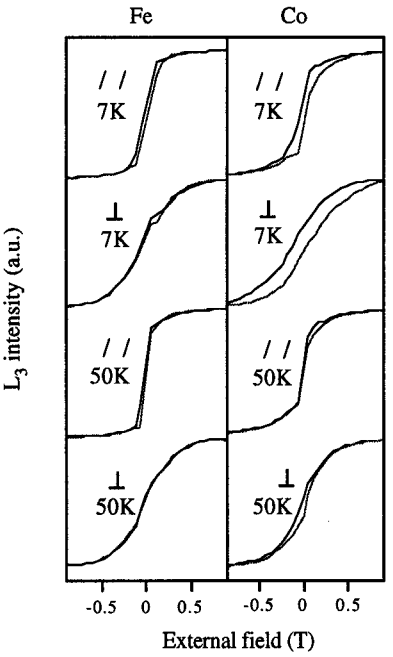
*Magnetism of exposed and Co-capped Fe nanoparticles*
K.W. Edmonds, C. Binns, S.H. Baker, M.J. Maher, S.C. Thornton, O. Tjernberg, N.B. Brookes, submitted to Phys. Rev. B, 28th January 2000.


### Abstract

The effect of capping a dilute assembly of nanoscale mass-selected Fe clusters with a Co thin film has been studied using x-ray magnetic circular dichroism (XMCD). The clusters, containing around 400 atoms, were deposited *in-situ* from a gas-aggregation source onto highly oriented pyrolytic graphite. The exposed clusters possess magnetic moments that are enhanced compared to the bulk, by around 4% for $m_{spin}$ and around 75% for $m_{orb}$. In addition, a surface core level shifted component is observed in the $L_{3,2}$ XMCD spectrum. Upon adding the Co layer, the surface component disappears, $m_{orb}$ is decreased for the Fe clusters, and $m_{spin}$ increases. A large increase in the anisotropy between in-plane and out-of-plane magnetisation directions is also observed.


Orbital and spin moments in exposed, mass-selected Fe clusters on graphite. Filled (open) circles are measurements at normal (55°) incidence respectively. Dashed lines are the measured bulk values.




Magnetisation curves of the Co-capped Fe cluster sample (400 atom clusters), measured from the x-ray absorption cross-section at the Fe $L_3$ edge (left) and the Co $L_3$ edge (right). Measurement temperatures are indicated.