ESRF	**Experiment title:** Magnetic Properties of Supported Co Clusters	**Experiment number:** HE-234
Beamline: ID21B	**Date of experiment:** from: 7 Nov 97 to: 13 Nov 97	**Date of report:** 22 Feb 98
Shifts: 16	**Local contact(s):** J.B. Goedkoop	*Received at ESRF:*

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Report:

Magnetic nanostructures have unique properties that are not present in bulk materials due to their reduced symmetry. In ultrathin films and layered materials a variety of new phenomena have been discovered with possible applications in information storage technologies. Further reduction of the system dimensions promises additional novel electronic and magnetic phenomena due to quantum size effects. Of recent interest is for instance the giant magneto-resistance in granular films consisting of nanoscale magnetic particles embedded in a non-magnetic conducting matrix.

The case of magnetic clusters supported on solid surfaces is particularly interesting since it allows high-quality structural characterization with conventional surface science techniques. Ordered arrays of supported Co clusters were grown in-situ by molecular beam epitaxy using the preferred nucleation of deposited Co adatoms at the elbows of the Au(111) herring-bone reconstructed surface. [l] In order to retain a permanent magnetic moment, a cluster must have a sufficient volume for the anisotropy barrier between different magnetization directions to be greater than the thermal energy. For a given size, clusters are superparamagnetic at high temperatures and exhibit a remanent magnetic order below the blocking temperature.

Element-specific hysteresis loops are shown in Fig. 1 for different sample temperatures. The measurements were taken by monitoring the fluorescence yield of circularly polarized x-rays with a photon energy set to the Co L_3 edge. The magnetic field was applied along the photon incidence direction which was 15° relative to the surface normal. The hysteresis loops clearly show a magnetic phase transition with a blocking temperature of 100 K. In the superparamagnetic temperature region, the loops can be modeled by a Langevin function. [2] Form a detailed fit we obtain a cluster size of 1500 atoms/cluster. Since the clusters are known to be disc-like in shape with a height of two atomic layers (AL) the determined size agrees well with the Co coverage of 0.5 AL. [1,2]

We found a dramatic variation of the blocking temperature with cluster size. The smallest clusters (400 atoms) studied exhibit remanent magnetic behavior below 40 K. With increasing cluster size the blocking temperature increases until it passes through room temperature close to two AL where a continuous Co film is formed.

References:

[l] B. Voigtlander, G. Meyer, N.M. Amer, Phys. Rev. **B 44,10354 (1991).**

[2] H. Takeshita, Y. Suzuki, H. Akinaga, W. Mizutani, K. Ando, T. Katayama, A. Itoh, K. Tanaka, .I. Magn. Magn. Mater.165, 38 (1997).

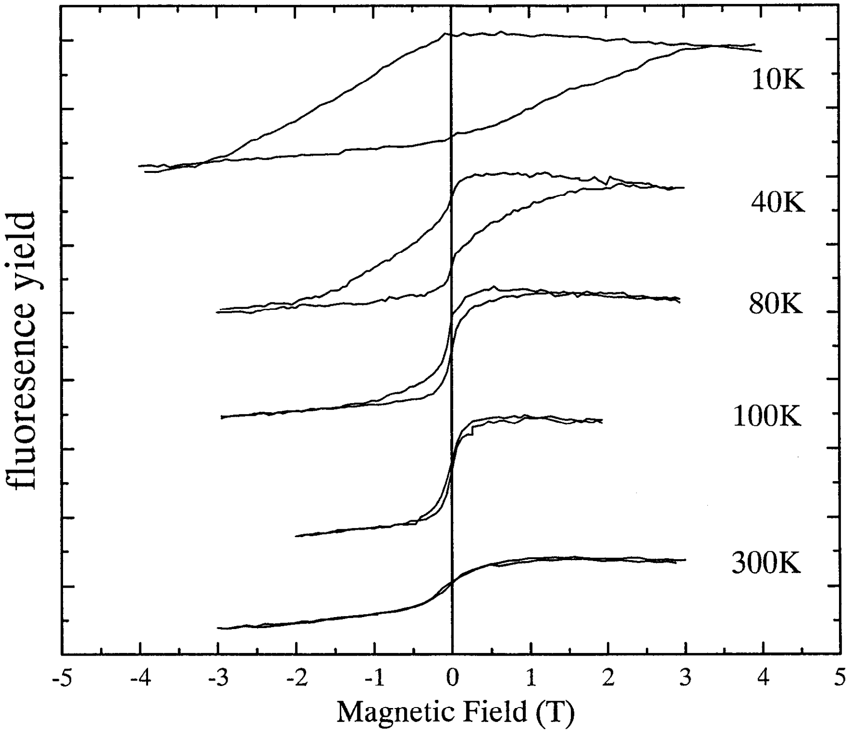

Fig.1: Hysteresis loops taken with the magnetic field 15° relative to the sample normal. The sample magnetization was monitored with MCXD at the Co L_3 edge.