ESRF	Anomalous GISAXS study of self-assembled $CoPt_3$ nanostructures grown on $WSe_2(0001)$	**Experiment number:** SI 814
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Names and affiliations of applicants (* indicates experimentalists):
M. Maret*, J.P. Simon*
LTPCM-ENSEEG BP 75 38402 Saint Martin d'Hères Cedex, France
I. Guhr*, U. Mazur*, G. Schatz
University of Konstanz, PO Box M621 D-78457 Konstanz, Allemagne

Report:

Grazing incidence small angle X-ray scattering experiments were performed at room temperature in self-assembled Mt-Pt (Mt=Co,Cr,Fe) alloy nanostructures grown on the 0001 van der Waals surface of the WSe_2 compound. After preliminary tests in july, these GISAXS experiments were the first ones performed on the small-angle setting up of the BM02 beamline. After the observation of a fast change in the GISAXS pattern of a $0.3\mathring{A}$ deposit of $CoPt_3$ alloy when maintained simply under a He flux, the other samples were then located in a box under a primary vacuum. During the measurement time, such box was sufficient to prevent any modification in the morphology of the nanostructures. Between the sample and the new Roper Scientific camera (1340x1300 pixels), a photomultiplicator monitor(PM) allows to optimize the reflectivity and the grazing incidence angle and a stripe beam stop to remove the intense specular spot. In contrast with well-manufactured Si or sapphire substrates, the reduced size of the WSe_2 monocrystals prepared by an iodine vapour transport technique and their imperfect flatness on the whole surface required to select a region, which lead to a localized specular spot completely masked by the beamstop. The distance between the sample and the detector placed perpendicular to the incident beam was of 630mmm and the wavelength of 1.7712 eV. The alloy nanostructures were grown between 20 and 300°C on small monocrystals of WSe_2 by co-deposition of Mt and Pt in a molecular beam epitaxy chamber. They were transferred in a high vacuum travelling system and thus carried on BM02. The deposited thicknesses for the three studied alloys, namely $CoPt_3$, $CrPt_3$ and FePt, were between 0.1 and 1Å. Due to the weak interactions with the Se planes, the deposited atoms are highly

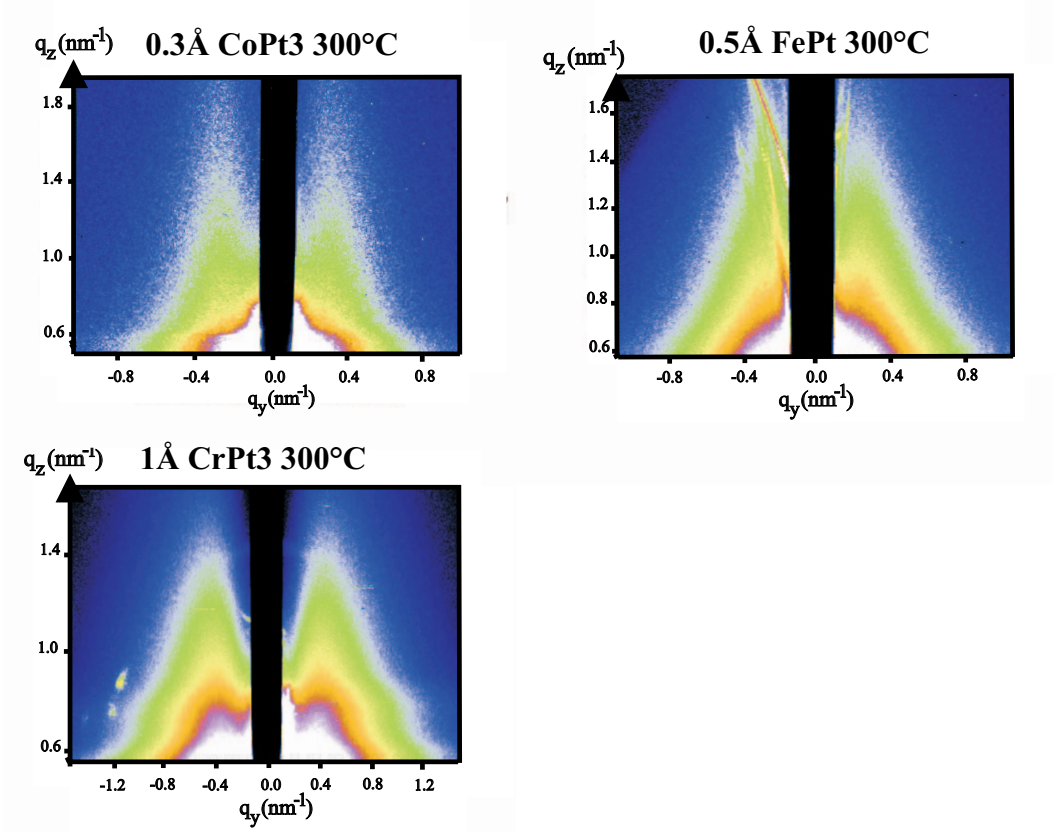

Fig.1: GISAXS patterns of magnetic alloy nanostructures grown at 300°C on WSe_2(0001); the nominal coverages are 0.3, 0.5 and 1 Å for $CoPt_3$, FePt and $CrPt_3$.

mobile and self-assemble to form islands which from RHEED observations grow along the [111] direction in epitaxial relationships with the substrate. Dark current and flat field corrections were applied to the patterns. Figure 1 shows the GISAXS patterns of three alloy deposits exhibiting interference peaks. Radial analyses in horizontal and vertical stripes of the CCD camera allow the determination of the average lateral size d and height h of nanostructures using the Guinier approximation. The position of the interference peak gives the average separation Λ between nanostructures. The d, h and Λ parameters of nanostructures grown at 300°C are respectively equal to 8, 1.5 and 21nm for a 0.3 Å deposit of $CoPt_3$, 8 and 4, 1.7 and 27nm for 0.5 Å of FePt and 4, 1.5 and 15nm for 1Å of $CrPt_3$. For $CoPt_3$ and FePt these values can be compared to those extracted from the STM images recorded on similar deposits. For the $CoPt_3$ sample maintained under a He flux the GISAXS values are slightly larger, suggesting an increase in size of the nanostructures already after a measurement time of 8min. For FePt the two size distributions centered around 4 and 8nm are also larger than the size of the individual islands observed by STM about 2.5nm. The separation distance of 27nm corresponds to the distance between groups of self-organized islands along preferential directions observed by STM. Due to the insufficient quality of the WSe_2 surface state, no anomalous measurements were attempted. Instead, we have measured Si nanodots grown on oxidized silicon wafers. The GISAXS patterns have revealed the influence of the oxide layer thickness on the morphology and distribution of the Si nanodots.