ESRF	**Experiment title:** Composition and temperature influence on the [001] texture formation in highly distorted rapidly annealed FePtCu thin films grown on amorphous substrates	**Experiment number**: 02-02-752
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Names and affiliations of applicants (* indicates experimentalists):

MAKAROV Denys, Institute of Physics, Chemnitz University of Technology, Germany

MARET Mireille, SIMaP, Grenoble-INP, France (*)

ALBRECHT Manfred, Institute of Physics, Chemnitz University of Technology, Germany

Report:

FePt(5nm-x)/Cu(x) bilayers have been sputter-deposited at room temperature on thermally oxidized Si (100) substrates. The thickness of the SiO_2 layer was 100 nm and the Cu thickness x was varied from 0.0 nm to 1.2 nm and the sputter pressure was adjusted to 3.5 10^{-3} mbar for all depositions. These layer-stacks have been further processed under N_2-atmosphere by rapid thermal annealing (RTA) up to 600°C or 800°C (heating rate of 400°C/s) and maintained at these maximal temperatures for 30s. This process leads to the formation of ternary FePtCu layers with Cu composition varying from 0 to 21at%, all exhibiting perpendicular magnetic anisotropy.

The formation of ternary FePtCu alloys with [001] texture was well confirmed by x-ray diffraction using a wavelength of 0.688 Å. The measurements of the 00l fundamental and superstructure reflections up to the 6^{th} order and their corresponding rocking curves have allowed the extraction of the *c* lattice parameter, the Debye-Waller factors, as well as the mosaic angle and the lateral and perpendicular coherence lengths. The 001 and 002 reflections are shown in figure 1 for the two series of annealed samples. The measurements of the 0-22 and 1-11 diffraction peaks have lead to the *a*-lattice parameter, confirming the tetragonal structure of the 001-oriented grains which adopt any orientation in the (001) plane. For pure FePt films, the chemical order parameter S increases from 0.7 after annealing at 600°C to S = 0.79 after annealing at 800°C. For the ternary alloys assuming that the Cu atoms are preferentially located on the Fe enriched planes, up to xcu=9at% the two independent chemical order parameters S_{Fe} and S_{Pt} would thus increase somewhat with annealing temperature, while for x_{Cu}=15 and 21at% they decrease slightly. Nevertheless, an accurate determination of S_{Fe} and S_{Pt} requires to perform anomalous diffraction measurements at the two edges of the majority atoms (Fe K-edge and L_{III}-Pt edge) and it is especially true for S_{Fe} strongly correlated to the arrangement of Cu atoms.

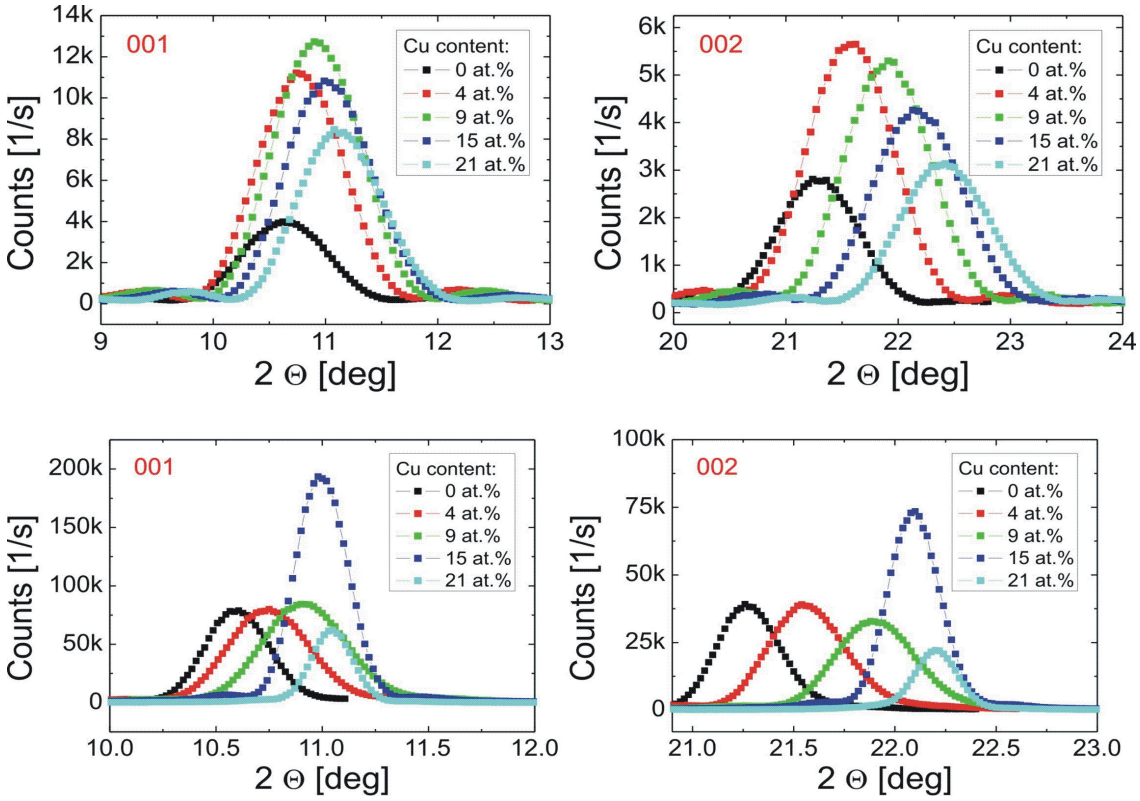

Figure 1: 001 and 002 reflections measured for the $(FePt)_{1-x}$ Cu_x alloy films after RTA annealing up to 600°C (upper curves) and 800°C (lower curves) and maintained at these temperatures for 30s.

The increase of Cu content enhances the tetragonal distortion resulting from a decrease of *c* from 3.73 to 3.54 Å (represented by the shift of the 001 and 002 reflections towards larger scattering angles in fig.1) and a small increase of *a* from 3.9 to 3.94 Å. This trend is still more marked after annealing at only 600°C. The perpendicular coherence lengths found for the samples annealed at 600°C are between 4.6 and 5nm, i.e. close to the initial layer thicknesses. In contrast the values for the samples annealed at 800°C are twice even third times larger than the layer thicknesses, due to a dewetting of the layers confirmed by AFM. The analysis of the FWHMs of rocking curves as a function of the reflection order leads to values of mosaic angles close to 1.5 and 3 deg for the samples annealed at 800°C and 600°C respectively, indicating a clear improvement of the texture after 800°C annealing. The lateral coherence lengths extracted from this analysis which are typically twice smaller after annealing at 800°C are thus in agreement with dewetting process. Nevertheless the FWHM of the rocking curves is essentially determined by the mosaic angles. Therefore, the drastic increase of the reflection intensities between the two series (see the upper and lower curves in fig.1) is due to both an increase of the height of the 001 textured grains and a decrease of the mosaic angle. These combined effects are really pronounced for the sample with 15at% Cu and annealed at 800°C. The favorable role of Cu atoms in the formation of the 001 texture and in the ordering of the superstructure is reflected by the values of the Debye-Waller factors. These factors determined for the series annealed at 600°C lead to atomic displacements on the superlattice which decrease from 0.2 Å for x_{Cu}=0% down to 0.1 Å for x_{Cu}=21%.

Finally, our x-ray results indicate that a Cu composition of 9% maximizes the chemical ordering and it is true for the two annealing temperatures.