

 ROBL-CRG	Experiment title: MgO crystals implanted with Fe and Pt ions	Experiment number: 20-02-662
Beamline: BM 20	Date of experiment: from: 21.06.2008 to: 24.06.2008	Date of report: 13.11.2008
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Report:

In order to investigate possibility of formation of strongly ferromagnetic Fe-Pt secondary phase in MgO crystals, Fe and Pt ions (with equal fluences of $4.6 \times 10^{15} \text{ cm}^{-2}$) were implanted to MgO matrix at energies of 173 and 500 keV respectively. The Fe implantation was performed at room temperature (RT) and at high temperature (HT) of 800 °C. Selected samples were annealed during 2 hours at 800°C in vacuum with residual gases pressure less then 2×10^{-6} mbar. The structural characterization was performed using monochromatic synchrotron x-ray radiation with a wavelength $\lambda = 1.239864 \text{ \AA}$. Longitudinal and transverse scans were used to analyse the coherent and diffuse x-ray scattering.

Diffraction peaks from secondary phases were not detected for the as-implanted, as well as, for annealed samples. However, there is clear evidence, that after implantation, a region enriched with Fe-Pt creates strongly strained layer near the specimen surface (FIG. 1a). The strain, ϵ , reaches value of 6.77×10^{-3} . After annealing, strains in near-surface area disappear. Enhanced diffuse x-ray scattering of annealed samples (FIG.

1b), points out to a presence of embedded substructure in the annealed samples. According to our computations, embedded particles create strong deformations in a range of 35 nm from the particle core. Estimated concentration of nanoparticles is 1.5×10^{11} per sample ($10 \times 10 \times 0.5 \text{ mm}^3$).

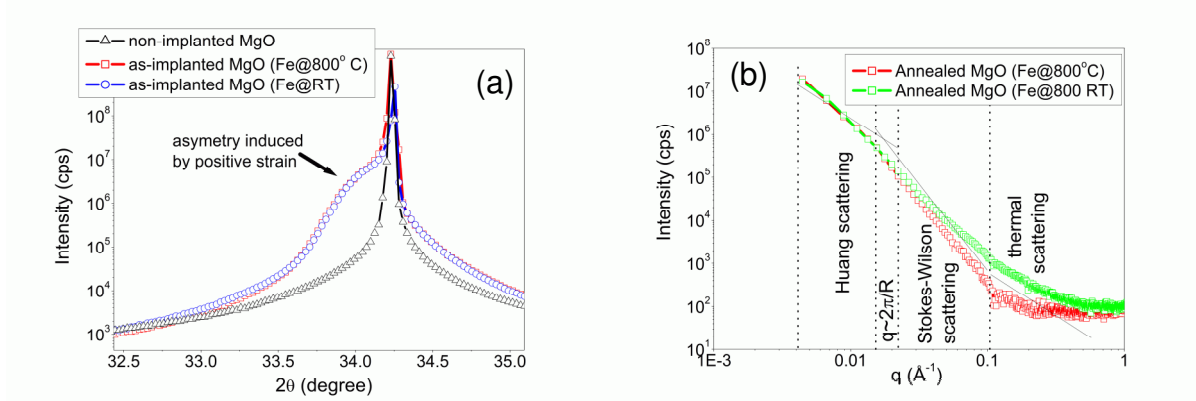


Fig. 1. a) 2θ - ω scans of MgO and MgO implanted with Fe and Pt; b) Diffuse scattering of annealed MgO crystals implanted with Fe and Pt.

Influence of annealing at 800°C under high hydrostatic pressure (HP) of 10 kbar on secondary phase formation was studied for the set of MgO crystals implanted with Fe ions (fluences: MgO:Fe#1 $-3 \times 10^{16} \text{ cm}^{-2}$, MgO:Fe#2 $-6 \times 10^{16} \text{ cm}^{-2}$, MgO:Fe#3 $-1 \times 10^{17} \text{ cm}^{-2}$, MgO:Fe#4 $-3 \times 10^{17} \text{ cm}^{-2}$, $E=100 \text{ keV}$, at target temperature of 800°C).

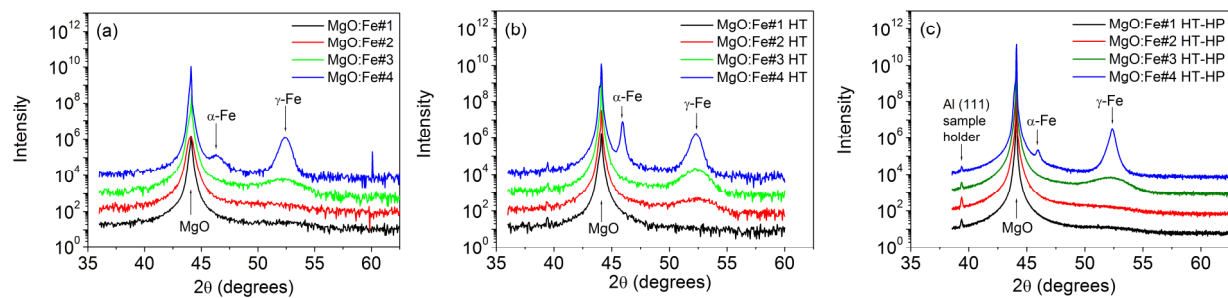


Fig. 2. $2\theta/\omega$ scans of MgO:Fe: a) as-implanted, b) after HT and c) after HT-HP annealing.

HT-HP annealing leads to formation of smaller ferromagnetic α -Fe particles and bigger paramagnetic γ -Fe particles with respect to as-implanted or HT annealed samples (dimensions were calculated from $2\theta/\omega$ scans shown in FIG.2).