ROBL-CRG	**Experiment title:** Structural investigation of Fe implanted MgO	**Experiment number**: **20_02_654**
Beamline: BM 20	**Date of experiment**: from: 24.08.2007 to: 30.08.2007	**Date of report**: 17.12.2007
Shifts: 18	**Local contact(s)**: Dr. Carsten Baehtz (baehtz@esrf.fr)	*Received at ROBL:*

Names and affiliations of applicants (* indicates experimentalists):

A. Shalimov*, S. Zhou*****, K. Potzger, C. Baehtz*****

Forschungszentrum Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O.B. 510119, 01314 Dresden, Germany

Report:

Embedded ferromagnetic nanoparticles are currently under intense research due to their application capability in ultrahigh density data storage, magneto-optics, and magneto-transport, as well as in basic research as model systems for time-resolved experiments for fast magnetization switching or electron holography.[1] Investigations on Fe nanoparticles inside MgO single crystals, synthesized by means of high temperature ion implantation, are performed.

In recent study of the Fe implanted MgO crystals, superparamagnetic temperatuire dependences and hysteretic magnetization isoterms were observed using superconducting quantum interference device (SQUID, Quantum Design MPMS). It was found that the magnetic moment of MgO:Fe structures is stronly depend on the dose of implanted ions and applied temperature. This magnetic behavior of MgO:Fe is associated with self-organized iron nanoparticles, which can be presented by two structural phases, namely, α- and γ-Fe. In order to determine the iron phase responsible for observed magnetization and the size distribution of Fe nanoparticles, a highly sensitive structural analysis, i.e. synchrotron radiation x-ray diffraction (SR-XRD), is required.

Results

The measurements of SR-XRD point out to the strong correlation between the implanted dose of Fe and structural properties of MgO:Fe. The samples with low dose of implanted Fe do not show a presence of iron phases. It can be a consecution of a very small dimension of the nanoparticles and eventually could be analized using a diffuse scattering of x-ray diffraction pattern. The MgO crystals implanted with doses $(0.6\text{-}1)\times10^{17}$ cm^{-2} possess embedded γ-Fe nanoparticles. The α-Fe nanoparticles appear in the sample with the highest dose of implanted ions, especially intensively

after thermal annealing. We belive that creation of α-Fe nanoparticles in the sample with the highest dose of implanted ions take place as a result of internal strain decreasing due to increased dimension of γ-Fe nanoparticles. Strong crystallographic correlation between α-, γ-Fe nanoparticles and MgO matrix was observed. The theoretical modeling of the magnetization properties, using the obtained structural characteristics of the studied systems, is in preparation.

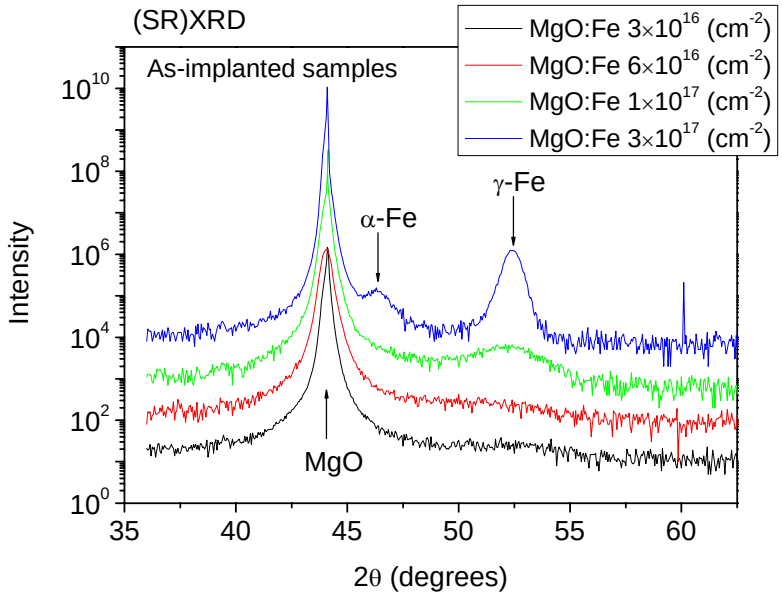

Fig. 1. SR-XRD 2θ/ω scans of MgO:Fe crystals with different dose of implanted Fe ions (doses of implantation are indicated).

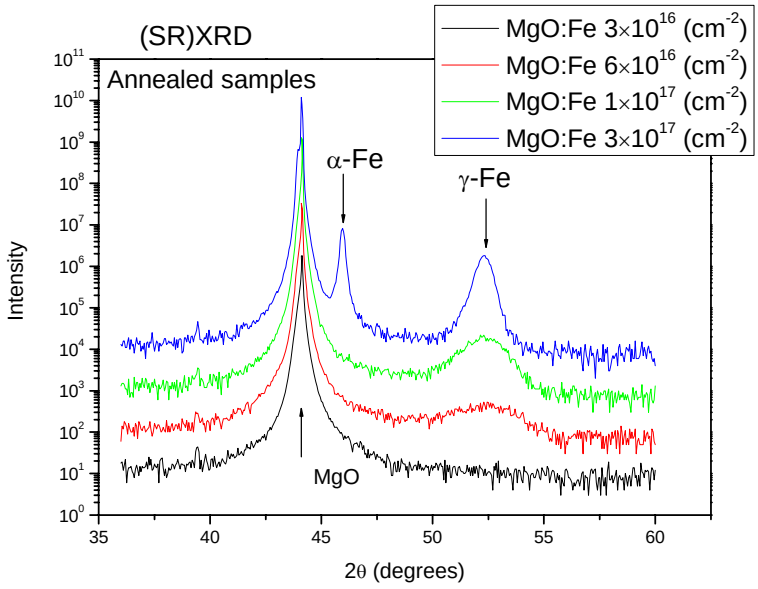

Fig. 2. SR-XRD 2θ/ω scans of annealed at 1023K MgO:Fe crystals with different dose of implanted Fe ions (doses of implantation are indicated).

References

[1] K. Potzger et al., J. Appl. Phys., 99, 08 N 701 (2006).