ROBL-CRG	**Experiment title:** Structural investigation of Fe implanted TiO_2	**Experiment number**: **20_02_650**
Beamline: BM 20	**Date of experiment**: from: 06.05.2007 to: 08.05.2007	**Date of report**: 17.12.2007
Shifts: 9	**Local contact(s)**: Dr. Carsten Baehtz (baehtz@esrf.fr)	*Received at ROBL:*

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Report:

TiO_2 is a kind of wide-band gap semiconductor. The bandgap is 3.0 eV for rutile TiO_2 (3.2 eV for anatase). Transition metal doped rutile and anatase TiO_2 have been reported to be ferromagnetic above room temperature by various groups [1]. However, it was also found that the measured ferromagnetic properties can originate from nanoscale precipitates, or defects inside TiO_2. Recently several review articles have addressed the complexity of transition metal doped oxides concerning the origin of ferromagnetism [2, 3]. In order to unambiguously clarify the origin of the observed ferromagnetism, a highly sensitive structural analysis, i.e. synchrotron radiation x-ray diffraction (SR-XRD), and an elemental selective magnetization measurement, i.e. x-ray magnetic circular dichroism (XMCD), is required. By XMCD, Co and Fe_3O_4 precipitates are found to be responsible for the ferromagnetism in $CoTiO_2$ [4] and Fe:TiO_2 [5], respectively. In the current paper, a correlation between structure and ferromagnetism in transition metal implanted TiO_2 is presented. SR-XRD was used to detect the phase separation, superconducting quantum interference device (SQUID, Quantum Design MPMS) magnetometry has been used to determine the temperature dependent magnetization and the hysteresis curves. We assign the observed ferromagnetism to Fe nanocrystals (NCs). The post-annealing procedure resulted in the out diffusion of Fe and a phase transformation of the precipitates. These Fe NCs are highly textured.

Results

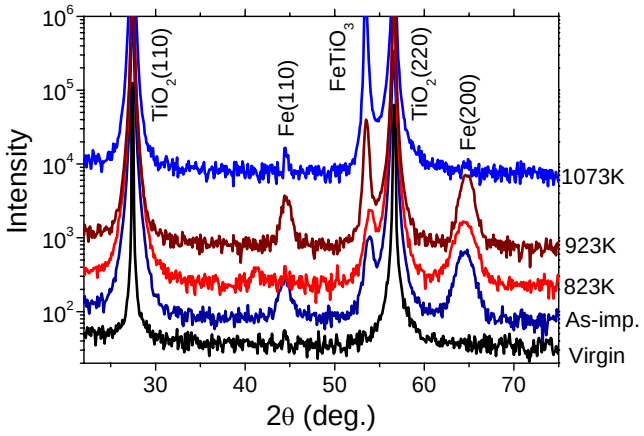

Fig. 1 SR-XRD symmetric 2θ-θ scans reveal two secondary phases: α-Fe and $FeTiO_3$ (annealing temperatures are indicated). After annealing at 1073 K, $FeTiO_3$ is the predominant precipitate.

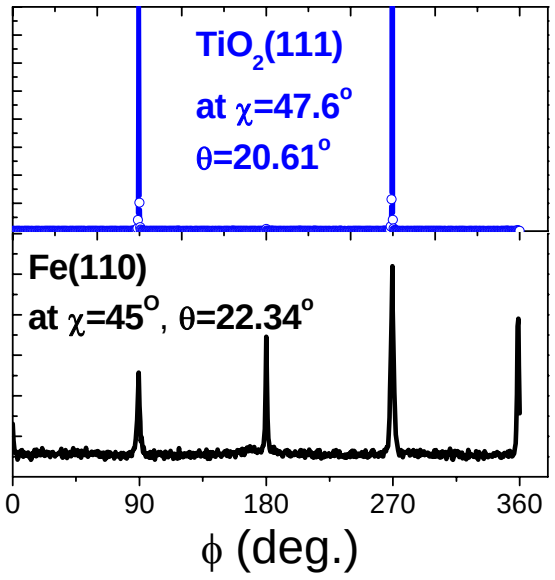

Fig. 2 SR-XRD φ-scans of Fe(110) and TiO2(111) for the 923 K annealed sample. Fe(110) and TiO_2(111) peaks are in the same azimuthal position, revealing the in-plane orientation relationship of Fe[010]//TiO_2 [1$\underline{1}$0].

References

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