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Magnetic Resonance Study of Fe-Implanted TiO2 Rutile

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Abstract

© 2017, Springer-Verlag Wien.Single-crystal (100) and (001) TiO_2 rutile substrates have been implanted with 40 keV Fe^+ at room temperature with high doses in the range of (0.5–1.5) × 1017 ions/cm2. A ferromagnetic resonance (FMR) signal has been observed for all samples with the intensity and the out-of-plane anisotropy increasing with the implantation dose. The FMR signal has been related to the formation of a percolated metal layer consisting of close-packed iron nanoparticles in the implanted region of TiO_2 substrate. Electron spin resonance (ESR) signal of paramagnetic Fe^{3+} ions substituting Ti^{4+} positions in the TiO_2 rutile structure has been also observed. The dependences of FMR resonance fields on the DC magnetic field orientation reveal a strong in-plane anisotropy for both (100) and (001) substrate planes. An origin of the in-plane anisotropy of FMR signal is attributed to the textured growth of the iron nanoparticles. As result of the nanoparticle growth aligned with respect to the structure of the rutile host, the in-plane magnetic anisotropy of the samples reflects the symmetry of the crystal structure of the TiO_2 substrates. Crystallographic directions of the preferential growth of iron nanoparticles have been determined by computer modeling of anisotropic ESR signal of substitutional Fe^{3+} ions.

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