

# Observation of Paramagnetic Fe<sup>3+</sup> in Mn/Fe implanted Metal Oxides and III-Nitrides

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Theoretical prediction of ferromagnetic behaviour above room temperature in ZnO (and GaN) doped with dilute concentrations (6 – 8%) of transition metal (TM) ions has excited considerable interest because of their potential as semiconductor-compatible magnetic components for spintronic applications. Observation of room temperature ferromagnetism (RTFM) in ZnO doped with TM ions have been reported, however, no clarity exists on the origin of the observed magnetism, which has been attributed to dopant-defect complexes, unintentional precipitation, or to the formation of secondary magnetic phases. The Mössbauer Collaboration at ISOLDE/CERN has applied <sup>57</sup>Fe emission Mössbauer spectroscopy following the implantation of <sup>57</sup>Mn<sup>+</sup>, to study the nature of the magnetism in ZnO and other metal oxides and III-nitrides. Radioactive beams of <sup>57</sup>Mn<sup>+</sup> (T<sub>1/2</sub> = 1.5 min) ions are produced at the ISOLDE facility following fission in a UC2 target induced by 1.4 GeV protons and multi-stage element selective laser ionization. High purity beams of intensity of ~3×10<sup>8</sup> ions/s were implanted with 40-60 keV energy and to fluences below 10<sup>12</sup> ions/cm<sup>2</sup> into commercially available single crystal samples. The Mössbauer spectra obtained on-line after implantation into ZnO single crystals show magnetic hyperfine sextets originating from Fe in the high-spin Fe<sup>3+</sup> state. Measurements in an external magnetic field show that these sextets are not due to ferromagnetic Fe but to paramagnetic substitutional Fe<sup>3+</sup> with unusually long relaxation times. Similar high-spin Fe<sup>3+</sup> paramagnetic sextet structure is also observed in MgO and alpha-Al<sub>2</sub>O<sub>3</sub>. Results obtained for ZnO, alpha-Al<sub>2</sub>O<sub>3</sub> and MgO, as well as preliminary results for GaN, AlN and InN, will be presented.

## Presentation Type

Oral

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