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An overview of emission 57Fe Mössbauer spectroscopy investigations in metal oxides

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Oxides, in particular ZnO doped with 3d-metal impurities has been of scientific interest since the suggestion that it could be a magnetic semiconductor with applications in spintronics [1]. 57Fe Mössbauer spectroscopy is a powerful method to determine the properties of the probe atoms, giving simultaneously information on the charge/spin state, site symmetry and on magnetic interactions. In this presentation, we report on emission 57Fe Mössbauer spectroscopy measurements following implantation of dilute 57Mn+ ions (<5×1012 cm-2) at ISOLDE/CERN in ZnO, α-Al2O3 and MgO single crystal samples held at temperatures between 77-800 K in an implantation chamber.

The spectra obtained for these materials are characterized by a magnetic structure on the wings of the spectra with the central region dominated by implanted ions occupying a combination of different lattice sites either due to interstitial Fe, substitutional Fe or probe atoms in amorphous surroundings due to the implantation damage. The magnetic hyperfine pattern of the spectra in each oxide is assigned to Fe3 + ions in a paramagnetic state with unusually long relaxation times observable at the highest measured temperatures [2]. This report will focus on a comparison of the derived hyperfine parameters, assigned charge states, extracted spin-lattice relaxation rates and observed annealing stages obtained for these materials. The results obtained from this study will be also compared with data obtained from 57Co and 57Fe implantations.

References

[1] Dietl et al., Science, 287 (2000) 1019
[2] Gunnlaugsson et al., Appl. Phys. Lett., 97 (2010) 142501

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