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Mössbauer study of spin-lattice relaxations of dilute Fe3+ in MgO

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We have measured 57Fe emission Mössbauer spectra following 50 –60 keV implantation of radioactive 57Mn+ (s) at the ISOLDE facility at CERN into MgO single crystals held at 77 –647 K (Fig. 1). This method allows us to study Fe impurities in concentrations <10-4 at.%. The central part of the spectra (Fig. 1) shows lines from Fe2+ on distorted lattice sites, substitutional sites, and interstitial Fe sites (see [1] for details). The wings of the spectra show what us in focus here; broad distributions of magnetic hyperfine fields up to ˜52 T, evidently slowly relaxing paramagnetic Fe3+.
These have been analysed/simulated with an arbitrary number of Blume-Tjon (BT) sextets [2] (here a minimum of five BT-sextets was needed, constrained by various common para-meters). The relaxation rate parameter W is allowed to vary with temperature. This parameter corresponds to a spin-relaxation rate of , where is the energy of the Mössbauer state. The (common) change of the BT-sextets is due to increasing values of W with temperature, which as found to increase to 1.5(9) mm/s (assuming mm/s at 77 K). In this range the line shape of the BT-sextets is dominated by broadening of the individual lines by . Figure 2 shows the relaxation rate obtained in this work compared to the results based on EPR measured relaxation rates of dilute Fe3+ impurities in MgO [3]. A reasonably good correlation between the two sets of data is obtained, demonstrating the possibility of retrieving spin-lattice relaxation rates using Mössbauer spectroscopy without the application of an external magnetic field. Other appli-cations of this technique will be given at this conference [4].

References:
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