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Study of Gadolinium Ion Matrices via EPR: Gd^{3+} as a Proximity Probe and Ligand Field Sensor

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Electron Paramagnetic Resonance (EPR) is a technique applied in various scientific fields, including dosimetry, structural determination of proteins, and studies on the generation of free radicals. It is also a highly efficient technique for studying paramagnetic species. In recent years, it has been possible to find reported studies primarily involving the Gd^{3+} ion, which provides information on the correlation of the signal from different glass composites with the crystal field where the Gd^{3+} ion is embedded [1]. Other investigations present information on the variation of the EPR signal from different Gd^{3+} complexes under a range of conditions. The Gd^{3+} ion (seven unpaired electrons) undergoes significant changes in its EPR signal, despite the spin-orbit interaction, responding to alterations in the ligand field, as reported by Miyamoto et al [2]. EPR spectra in CW X-Band were measured at room temperature (300K) to observe the Gd^{3+} signal under these conditions (Figure 1). In Figure 1, both pre- and post-thermal treatment gadolinium oxide exhibits a broadened signal, indicating strong magnetic coupling between the Gd atoms, while in the complex, a splitting of signals can be observed, although they are also broadened. To dilute the Gd^{3+} signal, new materials were synthesized from Y_2O_3 doped with different amounts of Gd^{3+} to determine the concentration at which magnetic interaction between Gd^{3+} ions is observed and to compare to literature in order to determine the ligand field that the Gd ions are occupying. The materials were characterized by XRD and the variation in the Gd signal was recorded via EPR measurement.

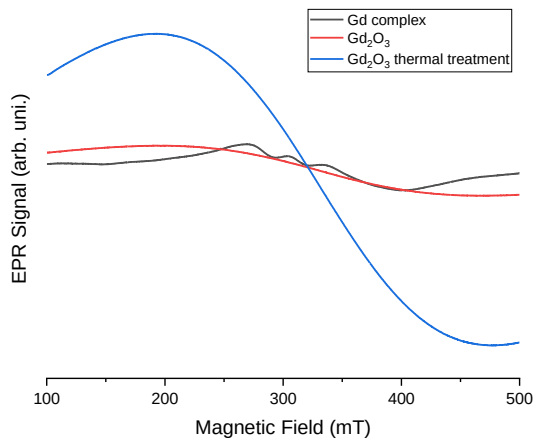

Figure 1. EPR spectra of the Gd^{3+} complex (black line), commercial Gadolinium oxide (red line), and commercial Gadolinium oxide after thermal treatment (blue line) recorded in the X-band (9.5 GHz) at room temperature (~300K).

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References

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