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Electron spin-lattice relaxation of Yb3+ and Gd3+ ions in glasses

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Abstract

The electron spin-lattice relaxation rate (T1 -1) was measured in two glass samples: (i) a phosphate glass doped with 1 wt% Yb2O3 and (ii) a Li2Si4O9 glass sample doped with 0.2 wt% Gd2O3. In the Yb3+-doped glass sample, T1, was measured by an electron-spin-echo technique from 4.2 to 6 K, by the modulation method from 10 to 26 K and by the EPR linewidth from 30 to 100 K. It was found that (T1 -1) ∝ Tn with n = 9 in the range 4.2-6 K. n decreased gradually as the temperature was increased and tended towards 2 above 40 K. Over the entire temperature range 4.2-100 K, (T1 -1) was fitted to AT + BT9J8 (ΘD/T) (where A and B are two temperature-independent constants, J8 is the well-known Van Vleck integral and ΘD is the Debye temperature). The value of ΘD (= 46.3±0.9 K) so determined is in good agreement with that of Stevens and Stapleton from their T1, measurements in the range 1.5 to 7 K. In the Gd3+-doped glass, it was observed that (T1 -1) ∝ T over the range 50-150 K. The data for Ye3+-doped glass sample were accounted for by assuming that the phonon modulation of the ligand field is the dominant mechanism, associated with a low Debye temperature in accordance with the published data obtained by using other techniques to study lattice dynamics. On the other hand, the data on the Gd3+-doped glass sample were explained to be predominantly due to a mechanism involving Two-Level-Systems (TLS).