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Spatial distribution of Nd3+ dopant ions in vitreous silica: A pulsed electron paramagnetic resonance spectroscopic study

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Abstract

The structural aspects of clustering of Nd3+ ions in Nd2O3-doped SiO2 glasses and the effect of Al3+ codoping on these clusters have been investigated with pulsed electron paramagnetic resonance (EPR) techniques over a temperature range of 1.5-4 K. The Nd2O3 concentrations in these glasses range between 700 and 2400 ppm by weight. The Nd3+ echo-detected EPR (EDEPR) spectra of the Al-free glasses show indications of weak exchange coupling between Nd3+ ions due to clustering. The EDEPR spectra also suggest that the local coordination environment of Nd3+ ions is affected by codoping with Al. The electronic spin-lattice relaxation rates are found to be not sensitive to the spatial distribution of Nd3+ ions over the entire temperature range of measurements. On the other hand, the concentration dependence of phase relaxation rates show clear evidence of clustering of Nd3+ ions in Al-free glasses, even at the lowest Nd2O3 doping levels. These Nd3+ clusters are found to break up and homogenize with an increase in the average Nd-Nd distance on codoping with Al. Analyses of the hyperfine sublevel correlation spectrum of a Nd and Al codoped glass indicate that the homogenization of Nd3+ clusters is possibly a consequence of the formation of Nd-O-Al linkages. © 2001 American Institute of Physics.

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