EXAFS studies of rare-earth metaphosphate glasses

ABSTRACT

An extended x-ray-absorption fine structure (EXAFS) study has been carried out on a range of rare-earth metaphosphate R(PO3)3 glasses of growing interest in optical communications and laser technologies. Phosphate glasses modified using the rare-earth oxides Pr6O11, Nd2O3, Eu2O3, Gd2O3, Tb2O3, and Ho2O3, have been investigated using their respective rare-earth LIII absorption edges. The data provide information on the local environment of the rare-earth ion within the phosphate glass matrix constructed from linked PO4 tetrahedra. The rare-earth ions occupy sites with an average coordination number in the range, 6ÒNÒ8, the surrounding atoms being oxygen. The first shell interatomic distance over the range of rare-earth ions establishes the rare-earth contraction of ionic radii with increasing atomic number in a series of glasses. There is also evidence for a rare-earth-phosphorus correlation between 2.7 and 3.6 Å, and a further rare-earth-oxygen correlation at approximately 4 Å. The EXAFS spectrum shows no evidence for R-R correlations within the short-range order, a result especially pertinent to the optical and magnetic properties of the glasses. The fractal dimensionality 4C11/B of these glasses, obtained from the elastic stiffnesses determined from ultrasonic wave velocities, ranges between 2.3 and 2.8, indicating that their connectivity tends towards having a three-dimensional character.

Keyword: Extended x-ray-absorption fine structure (EXAFS); Rare-earth; Metaphosphate glasses