Sol-gel method preparation silica gel-glasses, doped trivalent rare-earth ions for fiber optics applications

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Optical materials prepared by the sol-gel process are of current technological interest. Sol-gel silica glasses doped with rare-earth (RE^{3+}) ions are an important class of optical materials with applications including solid-state lasers, optical waveguides, fiber amplifiers and devices for optical communications.

There is currently a great deal of interest in the development of active glass devices that derive their important optical properties from organic or inorganic species doped into the glass. Among inorganic dopants, several of the trivalent rare earth ions are being investigated for use in lasers and devices for optical communications. Because of the high melting temperature of SiO_2, it is difficult to prepare rare-earth doped silica glasses using the traditional technique involving the quenching of an oxide melt. The sol-gel process provides a convenient alternative method for preparing doped glass samples without melting. The sol-gel method is a low-temperature solution method for glass preparation based on the inorganic polymerization of hydrolyzed metal alkoxides. Metal ion dopants to be incorporated in the final glass product are added to the initial solution in the form of inorganic salts, metal alkoxides or encapsulated metal complexes. The hydrolysis and condensation reactions driving polymerization continue, leading to the formation of a porous gel extending throughout the reaction vessel at the gel point. The porous gel is then dried and densified to form glass.

In this paper, we describe the preparation of rare-earth-doped silica-gel glasses and discuss the infrared properties of silica structure as a function of heat treatment. The samples were prepared from tetraethoxysilane (TEOS), water, ethanol, fumed silica and soluble in a water or ethanol the salts of the RE^{3+}(Er^{3+}, Nd^{3+}, Sm^{3+}) elements.