931 - Application of chromium-containing silicas for synthesizing functional glasslike materials by the Sol-Gel method

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A new variant of the sol-gel method for synthesizing optical silica glasses has been designed. The present paper is concerned with the possibility of application of chromium-containing silica (Cr/SiO_2) as a filler and source of doping ions. Highly disperse Cr/SiO_2 samples were synthesized through a step-by step controlled adsorption of vapors of chromium oxochloride and hexane on the surface of fumed silicas. The composition of the prepared dark-brown Etard complex is $3CrO_2Cl_2$-C_6H_{14}. The complex is firmly sorbed to the surface. When heated in air, it decomposes to form oxide groups of trivalent chromium. In the IR spectra of the modified silicas there are absorption bands at 635 and 575 cm^{-1} which are related to valence vibrations of Cr-O bonds. Our studies of Cr/SiO_2 by the XRD technique makes it possible to identify the applied phase as Cr_2O_3 nanoclusters. With increasing chromium concentration in samples from 0.9 to 5.1%, the size of chromium oxide nanoclusters increases from 10 to 46 nm.

The procedure employed for synthesizing chromium-containing sol-gel glasses involved the following subsequent stages: hydrolysis of TEOS in a triple-component system $Si(OC_2H_5)_4$-H_2O-HCl of starting compounds with their molar ratio of 1:16: 0.01; addition of Cr/SiO_2; thorough dispersion in an ultrasonic bath; neutralization of the reaction mixture to pH =5.5-6.5 using a solution of hexamethylenetetramine; gelation; drying of the gel; sintering in a furnace and holding at a temperature of 1140-1200°C for 1.5-2.0 hours in various atmospheres (air, helium, hydrogen).

Unlike the samples obtained by the conventional method, the samples that were synthesized using aerosils modified with chromium oxide possess a higher optical homogeneity and, in addition, exhibit an increase in their refraction index (= 633 nm) in comparison with a pure silica glass. This seems to be attributed to the fact that the new glasses contain nanodimensional crystals of chromium oxide.