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Sol-gel Materials for optics doped with transition elements

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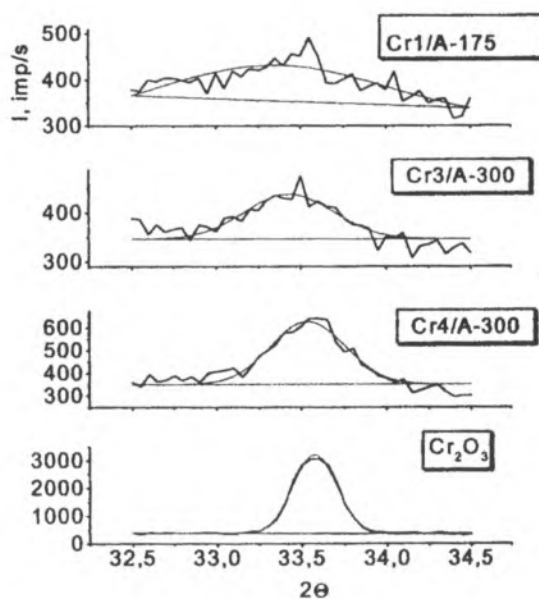
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The great interest in sol-gel synthesis of glasses and nanocomposites for optics and fiber glass optical systems has concentrated on the materials doped with transition elements[1]. The sol-gel method offers advantages in the technology of glass and incorporation of ions and nanoparticles of transition metals in the SiO₂ network produces different mechanism of absorption and scattering of visible and IR-radiation that determine the color and properties of the material.

We have made chromium- and copper-doped silica glasses and nanocomposites by modified sol-gel process[2]. In the quality of filler the modified by Cr, Cu compound aerosil A-300 was used. The new method used for the synthesis of Cr-containing fumed silica. The surface of SiO₂ agglomerates was covered by Cr₂O₃ structures by decomposition of chromium oxochloride-hexane complex. A phase of the oxygen compounds of chromium(+3) was formed by thermal oxidative destruction of the surface compounds at 600°C in air. New phase at silica surface were identified by X-ray diffraction as α-Cr₂O₃ nanocrystals (fig.). The dimensions of nanocrystalline silica particles modified with chromium oxide vary from 10 to 46nm in compliance with the increase in chromium content from 0.9 to 5.1%.

The nanopowders obtained were used for preparation of doped silica glasses by sol-gel method. The producing procedure includes Si(OC₂H₅)₄ hydrolysis, addition of fumed and modified silica, ultrasonic disintegration, centrifugal separation, introduction of a gelation reagent, and gel casting. When hardened samples were dried and heated step-by-step up to 1200°C until they became transparent glasses.

A dependence was examined of valence state of the optically active centers (chromium and copper ions and nanoparticles) within glass matrix on the temperature of xerogel treatment. The fumed silica modified by CuO nanoparticles was synthesized by the CVD-process with using of Cu(acac)₂. Spectral studies were carried out of the glasses obtained within UV-, visible, and IR-spectral ranges. The dimensions of nanocrystalline Cu⁰ in the silica matrix produced by modified sol-gel process followed by thermo-treatment in H₂(600°C) vary from 96 to 106nm. The homogeneity of optically active centers distribution within silica glass samples prepared from modified silicas has been shown to be better than that for doped glasses prepared by common used way with application of salt solutions.



References

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