Nanocomposites and nanomaterials

Features of opal-based nanocomposites fabrication

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Different techniques of fabrication of all-dielectric and metal-dielectric composites on the base of synthetic opals are discussed. Analysis is performed with drawing a great number of experimental results on X-ray diffraction, Raman scattering, Bragg light diffraction, and photoluminescence in synthetic opals impregnated with many active dielectrics with prominent photorefractive, nonlinear-optical, piezoelectric acousto-optic properties ($Bi_{12}SiO_{20}$, $Bi_{12}GeO_{20}$, TeO_2, Bi_2TeO_5, $NaBi(MoO_4)_2$, KH_2PO_4, $LiIO_3$, $Li_2B_4O_7$, $Pb_5Ge_3O_{11}$).

The melt-based and solution-based impregnation techniques are especially compared. The reasons of changing in chemical composition and structure parameters of the embedded substances, when the melt-based technique is used, are discussed. The chemical interaction of the melted filler with silica globules through their "softening" at high temperatures, due to the size-effect, is proved by X-ray diffraction and Raman scattering data. The interaction is observed not for all embedded compounds, and is most probably defined by "the rigidness" of the anionic sublattice of the embedded substance.

The solution-based technique does not result in drastic changes in chemical composition. However, it does not provide the high grade of pore filling for one impregnation cycle. The grade of pore filling is determined by a ratio between densities of solvent and embedded compounds.

Besides, the globule surface plays a dominant role in crystallization process. It may result in forming the other crystalline phases in case of polymorphism of the embedded substance.

The electrodeposition and thermal evaporation methods can be successfully employed in order to obtain metal-dielectric opal-based nanocomposites. The surface enhanced effects were observed in these structures.