Nanocomposites and nanomaterials

Destructive clustering of metallic nanoparticles in chalcogenide and oxide glassy matrices

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Plasmonic nanocomposite materials like glassy systems containing metallic nanoparticles (NPs) are of high importance in view of their promising application due to excellent nonlinear optical properties, such as increased high-order nonlinearities. In this view, the chalcogenide glasses (ChG), which possess few orders higher optical nonlinearities as compared with oxide glasses, attract a high attention. So, the chemical-technological resolutions allowing further enhancing these nonlinearities in glassy matrices seem very important.

Physical methods of NPs producing, such as ion beam implantation or laser irradiation, are *highly destructive* to ensure agglomeration of such *guest NPs* in *a host* glassy matrix. In relatively dense matrices, such as proper to vitreous oxides or ChG, interatomic linking of host glass structure should be significantly destroyed to accommodate embedded NPs. In such case, the agglomeration occurs under tight chemical interaction between NPs and components of destructed glass, the preferential character of this interaction defines the geometry of clustered NPs.

In this work, the principal difference in the origin of high-order optical nonlinearities caused by metallic NPs embedded destructively in oxide- and chalcogenide-type glassy matrices is justified from a viewpoint of covalent chemical bond approach. The numerical -criterion is introduced to describe this difference in terms of energetic barrier between mean molar bond energies character for inner chemical interaction of destructed components of *host* glassy matrix and *guest* implanted atoms such as Cu, Ag and Au. It is confirmed that destructive clustering of metallic NPs is possible in *hard* dielectric media like

oxide glasses possessing strong negative -criterion.