

Photoinduced formation of semiconductor nanocrystals in amorphous arsenic chalcogenides

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Amorphous arsenic chalcogenides are semiconductor materials known for numerous photoinduced effects under illumination by light of appropriate energy and intensity which makes them promising for various applications. We present a study of photoinduced formation of semiconductor nanocrystals in amorphous As–S(Se) films doped with metal atoms. The doped As₂S₃ and As₂Se₃ films with desired dopant content were prepared by thermal evaporation on silicon and silicate glass substrates. The prepared samples were of small surface roughness, however, as confirmed by the X-ray photoelectron spectroscopy data, the dopant content noticeably decreased with the film depth.

Raman spectroscopy (Horiba LabRAM HR 800 or Horiba XPLoRa Plus) was a technique to provide the light of appropriated energy and intensity, and simultaneously an in situ means of detection of the photoinduced changes in the material.

Frequencies of relatively sharp peaks that emerge in the Raman spectra of doped amorphous arsenic chalcogenide films at sufficient laser power densities correspond to phonons of nanocrystals formed on the film surface with the participation of the dopant atoms, e. g. CdS in As₂S₃:Cd, CdSe in As₂Se₃:Cd, ZnS in As₂S₃:Zn, etc. Laser-induced photosoftening of the amorphous arsenic chalcogenide films and enhanced diffusion result in energetically favourable formation of nanocrystals in the laser spot. The presence of nanocrystals is verified by Raman and photoluminescence (PL) spectroscopy. Raman spectroscopy can provide accurate identification of the nanocrystals formed in the amorphous As₂Se₃-based matrix under illumination while PL is a more sensitive technique to detect their presence in the sample.

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