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Optical properties of metal nanoclusters in amorphous diamond-like carbon matrix

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This paper presents comparative study results of silver (a-C:H<Ag> films) and platinum (a-C:H<Pt> films) clusters structure in amorphous diamond-like carbon films and optical properties. The films were fabricated by ion-plasma magnetron sputtering of combined polycrystalline graphite-metal target in hydrogen-argon gas mixture. The films were deposited on quartz and silicon substrates. The content of platinum and silver impurity in the carbon matrix was changed from 0 to 9 at. % and from 0 to 20 at. %, respectively. Concentrations of metal in the films were ranged by alteration of metal and graphite area relation in the combined target. Transmission electron microscopy revealed presence of isolated clusters in the films. It is noted, that diameter of platinum clusters weakly changed with an increase of a metal content and was 5 nm. On the contrary, the average size of the silver clusters grows from 2 nm at 2 at. % to 8 nm with a metal content grow to 20 at. %. In both type of films it was observed an absorption peak in the visible range of the optical absorption spectra. The absorption peaks in spectra of the a-C:H<Pt> films situated in the range from 495 to 498 nm and as for the a-C:H<Ag> films they lied at 420 nm. The intensity of the peaks rose with increase of metals concentration in the films. It is supposed that the absorption peaks in both cases are the result of surface plasmon resonance on metal clusters in the films. There were provided a modeling of the resonance absorption process with use of Mie theory for the isolated metal clusters imbedded in the dielectric matrix and it showed good coincidence with the experiment.

Keywords: metal nanoclusters, Diamond-like carbon, plasmon resonance