OPTICAL PERFORMANCE OF SILVER-DOPED DIAMOND-LIKE CARBON COMPOSITE FILM*

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Germanium and silicon substrates has high transparency in IR region and widely used as an window for equipment which a work in IR region, such as thermal and night vision cameras or sensors, and, very important, has an irreplaceable position in the field of infrared optics. However, due to the high refractive index of germanium (n = 4.3), the transmittance of germanium optical elements is only 40%, which seriously affects optical absorbance, especially leading to the destruction of optical elements at high transmitted radiation power. Therefore, it is necessary to prepare an infrared antireflection coating to improve the optical performance in IR region [1]. Diamond-like carbon film (DLC) has excellent light transmission performance in the mid-far infrared, so it can be used as an optical anti-reflection film for infrared optical elements [2,3]. DLC coatings together with excellent abrasion resistance and hardness have a low absorbance in the IR region, therefore it is an ideal coating for germanium windows and has broad application prospects. One way to change the optical characteristics of DLC coatings is to introduce metal into the coating structure. One of the main absorption peak of DLC is carbonyl absorption peak. And oxygen will preferentially combine with silver dropped in DLC [4].

The aim of this work is to study the effect of Ag concentration on the structure, mechanical and optical properties, such as refractive index, absorption coefficient and dielectric constant. Knowing these values will allow us to develop the design of a multilayer coating containing DLC layers and DLC:Ag with a different Ag content. DLC:Ag coatings was deposited on Si and Ge substrates use vacuum pulsed cathode arc deposition method. The concentration of silver in the DLC coatings was changed by using cathodes with different silver-to-carbon ratios.

The concentration of elements in the coating, the chemical composition, and the structure of the resulting coatings were investigated by XPS, XRD, Raman, TEM, SEM with EDS and IR spectroscopy.

The results of RDA studies have shown that with the same thickness of the coating (about 150 nm) with increasing silver concentration, its structure changes from spherical nanoparticles to single crystals with a cubic crystal structure.

At the same time, with the increase of silver content, the infrared transmittance of the DLC:Ag coatings gradually increases, and the area with a high transmission is expands from 500 cm^{-1} to 4000 cm^{-1} . In the sample with the highest silver content, the average transmittance is above 95%. It was found that the increase in silver content changes the interaction mechanism between silver and carbon atoms, and increase destruction of carbonyl and hydroxyl groups, which weaken the diamond-like carbon film's resonance absorbance to infrared light. The silver-doped DLC has good adhesion, and the friction coefficient is about 0.2

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