Brief information about the project

Name of the project	AP19676270 “Development of new nanocomposite materials based on HDLC films modified with iridium and palladium nanoparticles”
Relevance	Interest in the study of thin films of amorphous hydrogenated diamond-like carbon (HDLC) has been maintained over the past decades. The reason for this is the change in the properties of the films over a wide range. This opens up great opportunities for their practical application. HDLC thin films belong to the class of diamond-like carbon (DLC). The excellent properties of DLC, combining the characteristics of diamond and graphite are associated with structural features, which are determined by the ratio of sp^3/sp^2 hybridized bonds. The introduction of hydrogen atoms into the DLC structure in a certain way affects the ratio of sp^3/sp^2 sites. Impurity modification of HDLC films with transition metal atoms, namely, atoms of platinum group elements that do not form chemical bonding with carbon, can lead to the manifestation of new properties of the carbon matrix. The structure and electronic properties of composite films with impurities of non-carbide-forming metals of the platinum group can differ significantly from the properties of pure HDLC films, due to the manifestation of new processes associated with quantum size effects that are characteristic of nanoparticles (NPs). In the presented work, iridium and palladium, which are from the group of platinoids, are chosen as modifying elements. These elements are inert to the formation of carbides and form nanoparticles in the carbon matrix. At present, the incorporation of these elements into an HDLC matrix in the form of nanoparticles has not practically been studied. Therefore, the study of HDLC<Pd>, HDLC<Ir> films is necessary to understand the structural-impurity modification, namely the effect of Pd and Ir nanoparticles on the structure of the HDLC matrix and on the density of electron states. This will allow to understand deeply the nature of nanoparticles and the possibility of expanding the field of application of modified HDLCs in optoelectronic and other devices.
Purpose	The goal of the project is to carry out structural and impurity modification of HDLC films by changing the technological parameters of the synthesis and adding nanoparticles of metals - platinoids (Ir, Pd, Ir+Pd) using the magnetron sputtering method. To reveal the effect of synthesis conditions, concentration and size of Ir, Pd Ir+Pd nanoparticles on the formation of the structure and properties of nanocomposite HDLC films.
Objectives	*Objectiv 1.* Synthesis of thin HDLC films by magnetron sputtering at a given value of current and different powers of DC discharge in argon-hydrogen plasma. Study of the structure and properties of thin HDLC films depending on the synthesis conditions at given values of the DC

	discharge current, various values of hydrogen concentration, cathode voltage. Determination of the optimal technological parameters for the synthesis of HDLC films with a high content of diamond-like structural units. *Objective 2.* Structural - impurity modification of HDLC films with nanoparticles of metals Ir and Pd. Determination of the effect of DC discharge power on the structure and properties of HDLC<Ir>, HDLC<Pd> thin films. The introduction of platinoids nanoparticles will make it possible to affect in a certain way the ratio of sp^3/sp^2 hybridized bonds and the formation of the band structure of the amorphous matrix. Therefore, the amorphous HDLC matrix of Ir and Pd will be modified and the effect of the concentration of nanoparticles on the structure formation will be studied. *Objective 3.* Study of the structure and properties of composite HDLC <Ir+Pd> films synthesized at different DC discharge powers. Study of the effect of the concentration of <Ir + Pd> nanoparticles on the structure and electronic properties of HDLC thin films. The use of <Ir+Pd> in the form of nanoparticles as modifiers can significantly affect the density of states of the edge of the allowed zone of the amorphous matrix and, accordingly, lead to the manifestation of new properties associated with quantum size effects.
Expected and achieved results	Thin amorphous diamond-like films passivated with hydrogen will be obtained. The dependence of the electronic properties of nanosized HDLC films on the features of the local structure of the amorphous matrix will be revealed. The effect of hydrogen concentration on the formation of the structure and properties of thin HDLC films will be studied. Using the method of magnetron co-sputtering of a combined target, composite HDLC<Ir> and HDLC<Pd> nanofilms will be synthesized. The features of the formation of the local structure of the amorphous matrix of HDLC<Ir> and HDLC<Pd> films depending on the power of the DC discharge will be revealed. In addition, the influence of the concentration of Ir and Pd nanoparticles on structure formation and, as a consequence, on the electronic properties of thin composite hydrogenated diamond-like films will be studied. Thin HDLC<Ir+Pd> films will be synthesized at various values of DC discharge power. Work will be carried out to study the influence of the DC discharge power and the concentration of <Ir+Pd> nanoparticles on the electronic properties of HDLC nanofilms.
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