DIAMOND LIKE CARBON FILMS: GROWTH
AND CHARACTERIZATION

S. TAMULEVIČIUS* AND Š. MEŠKINIS
Institute of Physical Electronics of Kaunas University of Technology, Savanorių 271, 50131 Kaunas, LITHUANIA

Abstract – Present study is devoted to the application of the DLC films as wear resistant coatings for protection of surfaces of the steel tools as well as to the investigation of the optical and hydrophobic properties of SiOx and silicon doped DLC films. It was found, that in the case of the deposition of DLC on the steel surface chemical composition of DLC/interlayer interface as well as mechanical stress in interlayers and composition of hydrocarbon gas should be taken into account. Raman scattering spectra of the all synthesized amorphous carbon films were typical for DLC films. In the case of SiOx containing DLC films, Raman scattering spectra additional features typical for trans-polyacetylene-like segments has been observed. Contact angle with water of the all investigated films did not depend on the deposition conditions. Absorption coefficient of HMDSO + C2H2 films was several times larger than absorption coefficient of the HMDSO + H2 films, but substantially lower than absorption coefficient of DLC films deposited from acetylene gas. Additional Ar or N2 gas flow during the deposition resulted in increased optical transparence of SiOx doped DLC films (HMDSO + H2 films). Despite lower absorption coefficient, optical bandgap of HMDSO + C2H2 DLC films was smaller that optical bandgap of “conventional” hydrogenated DLC film.

Keywords: DLC, ion beam synthesis, SiOx containing DLC, XPS study, Raman scattering spectroscopy, optical properties, contact angle with water.

*To whom correspondence should be addressed: S. Tamulevičius, email: Sigitas.Tamulevicius@ktu.lt
1. Introduction

Diamond like carbon (DLC) and related films received considerable interest due to their outstanding properties. Diamond like carbon is a metastable form of the amorphous carbon containing significant amount of sp\(^3\) bonds.\(^1\) Due to that structural feature, properties of the diamond like carbon films are similar to the properties of the diamond. Hydrogenated DLC films are synthesized by different PECVD methods as well as by ion beam synthesis using different ion sources. Ion beam synthesis offer advantages of the increased deposition process control such as independent control of the ion energy and ion current density. Particularly DLC ion beam synthesis by closed drift ion source is already used in industry due to its relatively simple maintenance, because it is griddles and filamentless ion source. Despite numerous research devoted to the use of the diamond like carbon films in medicine, micro- and optoelectronics the main application areas of that films remains applications related to tribological and optical properties of DLC. Present study is devoted to the two applications of the diamond like carbon films.

The first one is related to application of the DLC films as wear resistant coatings for protection of surfaces of the tools or biomedical implants.\(^2^\)\(^-^\)\(^4^\) In this case hydrogenated amorphous carbon (a-C:H) films very often are deposited onto different steels and other ferrous materials. However, adhesion problems often occur in such a case.\(^5^\)\(^-^\)\(^7^\) Formation of intermediate layers between the ferrous substrate and diamond like carbon film has been the most common approach in order to solve these obstacles for diamond like carbon films deposited on the steel.\(^6^\) In present research interfaces of the DLC fabricated on different interlayers were investigated.

The second application is related to the tuning of optical, hydrophobic and mechanical properties of DLC. Recently nanoimprint lithography received considerable interest as a simple and cost effective alternative to the conventional lithographic techniques such as optical or electron beam lithography.\(^8^\)\(^,^\)\(^9^\) One of the most important problems to be solved in the nanoimprint lithography is fabrication of the stamps with anti-sticking surface. However, Si, quartz, Ni – the most often used materials for imprint stamp formation – have high surface energy and, as a result, bad antiadhesive properties. Till now low surface energy fluoride films such as Teflon-like coatings\(^10^\)\(^,^\)\(^11^\) and fluorinated silane layers\(^12^\)\(^,^\)\(^13^\) were investigated as anti-sticking layers for the nanoimprint stamps. However, protective film degradation due to the fluorine mass transfer at elevated imprint temperatures was observed.\(^10^\) After certain number of complete imprint cycles this film needs to be replaced. Diamond like carbon (DLC) films can be a good choice for this application due to the combination of the hydrophobicity with outstanding mechanical and tribological properties of these films.\(^1^\) Thick DLC