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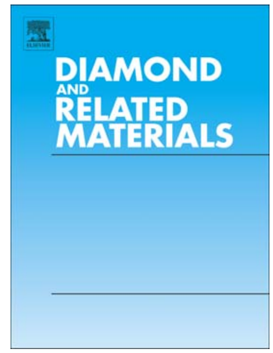

Structure and mechanical properties of oxygen doped diamond-like carbon thin films

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Structure and mechanical properties of oxygen doped diamond-like carbon thin films

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Abstract

In this study, structure and mechanical properties of doped diamond-like carbon (DLC) films with oxygen were investigated. A mixture of methane (CH_4), argon (Ar) and oxygen (O_2) was used as feeding gas, and the RF-PECVD technique was used as a deposition method. The thin films were characterized by X-ray photoelectron spectroscopy (XPS), Raman spectroscopy (RS), attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) and a combination of elastic recoil detection analysis and Rutherford backscattering (ERDA-RBS). Nano-indentation tests were performed to measure hardness. Also, the residual stress of the films was calculated by Stoney equation. The XPS and ERDA-RBS results indicated that by increasing the oxygen in the feeding gas up to 5.6 vol. %, the incorporation of oxygen into the films' structure was increased. The ratio of sp^2 to sp^3 sites was changed by the variation of oxygen content in the film structure. The sp^2/sp^3 ratios are 0.43 and 1.04 for un-doped and doped DLC films with 5.6 vol. % oxygen in the feeding gas, respectively. The Raman spectroscopy (RS) results showed that by increasing the oxygen content in doped DLC films, the amount of sp^2 C=C aromatic bonds was raised and the hydrogen content reduced in the structure. The attenuated total reflectance Fourier transform infrared spectroscopy (ATR-FTIR) confirmed the decrease of hydrogen content and the increase the ratio of C=C aromatic to olefinic bonds. Hardness and residual stress of the films were raised by increasing the oxygen content within the films' structure. The maximum hardness (19.6 GPa) and residual stress (0.29 GPa) were obtained for doped DLC films, which had the maximum content of oxygen in structure, while the minimum hardness (7.1 GPa) and residual stress (0.16 GPa) were obtained for un-doped DLC films. The increase of sp^3 C-C bonds between clusters and the decrease of the hydrogen content, with a simultaneous increase of oxygen in the films' structure is the reason for increase of hardness and residual stress.

Keywords: Diamond-like carbon, RF-PECVD, oxygen, Hardness, Residual stress

1. Introduction

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