PO4039

Chemical bonding and mechanical properties of O-doped DLC films synthesized by photoemission-assisted plasma-enhanced CVD

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In this study, oxygen-doped diamond-like carbon (DLC) films with low frictions for tribology application were synthesized by a photoemission-assisted plasma-enhanced chemical vapor deposition (PAPE-CVD) process was employed to synthesize, in which photoelectrons emitted from a UV-irradiated substrate are utilized as a trigger for generating DC discharge plasma, resulting in a low bias voltage, a high deposition rate, a low electric power consumption, and a less frequent maintenance due to the suppression of soot on the chamber walls and electrodes. CO_2 was mixed as a dopant gas to Ar-diluted CH_4 gases during PAPE-CVD on Si(111) substrates at 150□ and a total gas pressure of 200 Pa with a commercially available Xe excimer lamp (hv = 7.2 eV).
Raman spectroscopy and SIMS measurements showed that the DLC film was graphitized with increasing CO_2 concentration, even though the growth temperature was maintained at 150□ for all CO_2 concentrations, and the doped-O concentration of the DLC film was increased corresponding to the CO_2 concentration, although the amount of hydrogen atoms hardly changed independent of the CO_2 concentration. The results indicate that the oxygen-doped DLC film is composed of nanographite grains embedded in O-rich amorphous carbon matrix. The electric resistance of the O-doped DLC films was measured by a four-probe method to be over 100 MΩ□cm, indicating that the O-rich amorphous carbon matrix is a good insulator and the nanographite grains are not connected with each other but isolated with no electric path. The hardness was slightly increased at high CO_2 concentrations, although the O-doped DLC films were graphitized. The O-doping mechanism for the PAPE-CVD growth of DLC and the O-doping effect on the friction coefficient are considered.

Keywords
Diamond-like carbon
Photoemission-assisted plasma-enhanced chemical vapor deposition (PAPE-CVD)
Oxygen doping
Graphitization
Hardness and friction measurement