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Large-area deposition of carbon-containing amorphous films on glass or paper by low-pressure dielectric barrier discharges

Dongping Liu[1], Jinhai Niu[1]

[1]Dalian Nationalities University, Dalian, China

Dongping.liu@dlnu.edu.cn

Plasma deposited fluorocarbon (FC) films have been widely studied because of their remarkable properties, including a low dielectric constant (1.6-2.1), biocompatibility, and superhydrophobicity. Applications for such films include dielectric layers for the ultra-large scale integration devices, biopassivation coatings for implantable devices, and hydrophobic layers on paper. Diamondlike carbon (DLC) films exhibit many unique properties such as high mechanical hardness, chemical inertness, optical transparency, and low coefficient of friction. Unlike rough polycrystalline diamond films which are synthesized typically at above 700 °C by chemical vapor deposition (CVD), DLC films may be produced at room temperature and are extremely smooth. DLC films have been widely used as protective coatings in areas such as magnetic storage disks, optical windows and micro-electromechanical devices.
In this study, a specially designed dielectric barrier discharge (DBD) chamber has been used to deposit large-area (370mm´500mm) FC or DLC films on glass or paper. The deposited films exhibit the well thickness uniformity and extremely low surface roughness. The primary monomers used for plasma polymerization were difluoromethane (CH_2F_2), octafluoropropane (C_3F_8), and octafluorocyclobutane (C_4F_8). FC films were characterized using Fourier transform infrared spectroscopy, atomic force microscopy, static contact angle measurements, and scanning electron microscopy. Surface and structural properties of deposited films are strongly dependent on the plasma compositions and plasma parameters. FC films deposited on paper are to enhance its barrier properties and to achieve hydrophobic surfaces. Contact angle studies reveal that a minimum FC film thickness of about 200 nm on paper is required to completely cover surface and near-surface fibers, thereby providing the paper with long term hydrophobic character.
CH_4 discharge gas was used to deposit hard and large-area DLC films on glass. This study indicates that decreasing the CH_4 discharge pressure results in a large potential decline across the alternative and impulse DBD cathode sheath, thus a significant increase in the film hardness. This study shows that DLC is chemically inert and the DLC-coated glass is acid and alkali resistant. The DLC film deposited on large-area glass can be potentially used as a scratch resistant and corrosion barrier layer.

Keywords
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film deposition
polymer

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