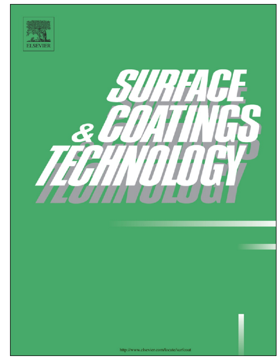

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PII: S0257-8972(18)30031-8
DOI: https://doi.org/10.1016/j.surfcoat.2018.01.023
Reference: SCT 23006

To appear in: *Surface & Coatings Technology*

Received date: 15 September 2017
Revised date: 7 January 2018
Accepted date: 9 January 2018

Diamond-like Carbon Film with Gradient Germanium-doped Buffer Layer by Pulsed Laser Deposition

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Abstract: Germanium-doped diamond-like carbon film with different germanium concentrations on the germanium substrate were prepared by double laser beams emitted from the femtosecond and nanosecond lasers. Diamond-like carbon film with gradient germanium-doped buffer layer, which was named as GDBL-DLC film, was prepared. The germanium concentration could be controlled easily by adjusting the repetition frequency of one of the lasers. Infrared transmission and hardness of the GDBL-DLC film kept high levels of above 60% and 45.4GPa. On the other hand, the critical load of the GDBL-DLC film on the germanium substrate increased to 143.7mN from 65.5mN of the pure diamond-like carbon film. In addition, the GDBL-DLC film had not been damaged after being rubbed by rubber stick and stuck by tape. It was shown that the GDBL-DLC film could be used as protective film for infrared windows.

Key words: diamond-like carbon film; pulsed laser deposition; gradient doped buffer layer

1 Introduction

Diamond-like carbon (DLC) films prepared by pulsed laser deposition (PLD) include the important sp3 bonds to have some unique properties, such as high elastic modulus, high mechanical hardness, low friction coefficient, chemical inertness and excellent heat-transfer conductance [1,2]. Therefore, DLC films are applied widely in the fields of mechanics, optics, electronics, and so on. However, high performance material with poor adhesion can't give better results than poor material quality with good adhesion [3]. Unfortunately, residual stress in the DLC film reaches above 2GPa usually so as to reduce its adhesion strength on the substrate [1~3].

Generally, metal doping is one important method to improve adhesion strength of the DLC films which included those prepared by PLD. Monolayer titanium-doped DLC films were prepared by two lasers (both λ=248nm) which ablated the graphite and titanium targets respectively, and critical loads (the token of adhesion strength) of the titanium-doped DLC film with 24.5at.% concentration increased monotonically to 11N and 18N accordingly while those of the pure DLC films on the silicon and Ti6Al4V substrates were 4N and 10N respectively [4]; Monolayer chromium-doped DLC films were prepared by two lasers (both λ=248nm) which ablated the graphite or chromium targets respectively, and critical loads of the chromium-doped DLC films with 17.9at.% concentration increased monotonically to 3.4N or 19.4N accordingly while those of the pure DLC films on the silicon or Ti6Al4V substrate were 2.5N or 5.4N accordingly, while nanohardness of the films on the Ti6Al4V substrate decreased monotonically to 16.9GPa from 51GPa [5]; Monolayer chromium-doped DLC films on the stainless steel were prepared by Nd:YAG laser (λ=1064nm) which ablated the graphite target with fan-shaped chromium, and critical load of the silver-doped DLC film with concentration at 7.8% increased monotonically to 2.6N compared with 1.5N of the pure DLC film [6]; Monolayer silver-doped DLC films were prepared by single laser (λ=248nm) wihch ablated the graphite target with silver strip, and critical loads of the silver-doped DLC films with concentration at 7.8% increased monotonically to 253.4mN compared with that of 145.4mN of the pure DLC film on the silicon substrate, while nanohardness of the films decreased monotonically to 10.5GPa from 19.6GPa [7]. The doped DLC films prepared by other deposition methods were reported in the references [8-9]. Further on, double laser beams split from picosecond laser (λ=355nm) ablated the graphite and steel targets respectively, and the gradient iron-doped DLC film with critical load of 47N on