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PII: S0257-8972(17)30187-1
DOI: doi: 10.1016/j.surfcoat.2017.02.044
Reference: SCT 22140

To appear in: *Surface & Coatings Technology*

Received date: 26 August 2016
Revised date: 13 February 2017
Accepted date: 15 February 2017

Please cite this article as: Jianliang Lin, Xuhai Zhang, Peter Lee, Ronghua Wei , Thick diamond like carbon coatings deposited by deep oscillation magnetron sputtering. The address for the corresponding author was captured as affiliation for all authors. Please check if appropriate. Sct(2017), doi: 10.1016/j.surfcoat.2017.02.044

Thick diamond like carbon coatings deposited by deep oscillation magnetron sputtering

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Abstract:

Hydrogenated diamond like carbon (DLC) coatings with thicknesses up to 20 μm have been deposited on metal substrates by sputtering a graphite target in argon (Ar) and acetylene (C_2H_2) mixture using deep oscillation magnetron sputtering (DOMS). The coatings were deposited under moderate peak target current densities (0.47 to 0.6 Acm^{-2}) at a low bias voltage of -60 V, to achieve dense microstructure but avoid building up of high residual stresses. Higher peak substrate current densities and deposition rates were found when C_2H_2 was introduced. The effects of the C_2H_2 flow rate (f_{C2H2}) on the deposition rate, microstructure, adhesion, mechanical and tribological properties of the DLC coatings were studied by means of scanning electron microscopy, Raman spectroscopy, HRC indentation, nanoindentation, dry ball-on-disk test, and block-on-ring test in SAE 10W-30 engine lubricant. The coatings showed low compressive stresses in the range of -0.5 GPa to -1.8 GPa. The coatings exhibited dense structure, high sp^3/sp^2 ratio, and excellent wear resistance when the C_2H_2 flow rate was in the range of 10-20 sccm (4%-8% of the total gas flow). However, the coatings deposited at higher C_2H_2 flows (>30 sccm or 13% of the total gas flow) showed decreased adhesion, hardness and wear resistance. The friction and wear behavior of the DOMS DLC coatings both in the ambient air and SAE 10W-30 engine lubricant showed positive results in terms of friction and wear reduction.

Key words: Diamond like carbon (DLC), deep oscillation magnetron sputtering (DOMS), high power impulse magnetron sputtering (HiPIMS), acetylene, low friction, wear.

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