



## Fracture toughness of duplex CrN/DLC and nano-multilayer DLC-W deposited on valve tappet via hybrid PVD and PECVD

FUNSHO OLAITAN KOLAWOLE<sup>1,\*</sup>, SHOLA KOLADE KOLAWOLE<sup>2</sup>,  
SEFIU ADEKUNLE BELLO<sup>3</sup>, SHEDRACH YAKUBU<sup>4</sup>, OLUWOLE DANIEL ADIGUN<sup>5</sup>,  
ADEBAYO FELIX OWA<sup>5</sup>, REGINALD UMUNAKWE<sup>5</sup>, ABDULLAHI OLAWALE ADEBAYO<sup>5</sup>  
and CHIOMA IFEYINWA MADUEKE<sup>5</sup>

<sup>1</sup>Metallurgical and Materials Engineering Department, University of São Paulo, Av. Prof. Mello Moraes 2463, São Paulo, SP, Brazil

<sup>2</sup>National Agency for Science and Engineering Infrastructure, Abuja, Nigeria

<sup>3</sup>Department of Materials Science and Engineering, Kwara State University, Malete, Nigeria

<sup>4</sup>Multifunctional Materials and Sensors group, Department of Science and Technology, Federal University Sao Paulo, Sao Paulo, Brazil

<sup>5</sup>Department of Materials and Metallurgical Engineering, Federal University, Oye-Ekiti, Nigeria  
e-mail: fkopresido@yahoo.com

MS received 29 December 2023; revised 18 January 2024; accepted 8 February 2024

**Abstract.** DLC coatings are well known for their high fracture toughness, however, often exhibit poor adhesion properties on metallic substrates. The use of interlayers and metallic doping can be used to overcome such challenge. In this study duplex CrN/DLC and nano-multilayer DLC-W coatings were both deposited on hydraulic valve tappet using a hybrid PVD/PECVD deposition system. Microhardness measurements were taken for the uncoated valve tappet, duplex CrN/DLC and nano-multilayer DLC-W coated valve tappet at loads of 0.98 N, 1.96 N, 2.94 N, 4.9 N, 9.8 N and 19.6 N for 15 seconds using a Shimadzu hardness tester. The fracture toughness was evaluated using the Vickers indentation method from microhardness indents on the surface of the coatings. The fracture toughness for duplex CrN/DLC and nano-multilayer DLC-W coatings indented at 4.9 N, 9.8 N and 19.6 N, reveals that the fracture toughness for the duplex CrN/DLC were  $20.24 \pm 0.97 \text{ MPa.m}^{1/2}$ ,  $17.18 \pm 0.86 \text{ MPa.m}^{1/2}$  and  $6.6 \pm 0.28 \text{ MPa.m}^{1/2}$  respectively. While the fracture toughness for nano-multilayer DLC-W was calculated as  $3.75 \pm 0.41 \text{ MPa.m}^{1/2}$  and  $4.67 \pm 0.38 \text{ MPa.m}^{1/2}$  at 9.8 N and 19.6 N respectively.

**Keywords.** Fracture toughness; duplex CrN/DLC; nano-multilayer DLC-W; microhardness.