Effects of carbon content and argon flow rate on the triboperformance of self-lubricating WS_2/a-C sputtered coating

H.T. Cao [1*], *J.Th.M De Hosson* [2] *and Y.T. Pei*[1]

1. Department of Advanced Production Engineering, Engineering and Technology Institute Groningen, Faculty of Mathematics and Natural Science, University of Groningen, 9747 AG Groningen, The Netherlands.

2. Department of Applied Physics, Zernike Institute of Advanced Materials, Faculty of Mathematics and Natural Science, University of Groningen, 9747 AG Groningen, The Netherlands.

Huatang.cao@rug.nl

Abstract

Layered transition metal dichalcogenides (TMD) such as WS_2 are materials well-known for their solid lubrication properties [1]. However, the lubricating property degrades through oxidation or moisture and it is also limited by its low hardness and low load-bearing capacity. In contrast amorphous diamond-like carbon (DLC) films are reported to have many features that contribute to excellent tribological characteristics, such as high hardness, anti-wear property with both low friction coefficient and low wear rate[2]. The present research aims at depositing WS_2/a-C nanocomposite coatings by magnetron co-sputtering method. The effects of carbon content and argon flow rate on the microstructure and mechanical performance were investigated. The WS_2/a-C nanocomposite tribocoating was scrutinized by electron microscopy and mechanical testing. Transmission electron microscopy reveals feathery WS_2 platelets, randomly distributed in the amorphous carbon matrix. The nanocomposite coating turns out to be more amorphous-like with increasing carbon content. Nanoindentations tests show that the hardness and elastic modulus of the coating increase with increasing carbon addition while decreasing with a higher argon flow from 10 sccm to 25 sccm.

Ball-on-disk tribotests (100Cr6 steel ball as a counterpart) show that the coefficient of friction can be as low as 0.017 in a dry environment (5% relative humidity). It reaches 0.15 in a high humidity surrounding and remains stable within 20000 sliding cycles.

References:

1. S. Prasad, J. Zabinski. Super slippery solids, Nature 387, 761-763(1997).

2. A. Nossa, A. Cavaleiro, N.J.M. Carvalho, B.J. Kooi, and J.Th.M. De Hosson, On the microstructure of tungsten disulfide films alloyed with carbon and nitrogen, Thin Solid Films 484 (1-2), 389-395(2005).