Tribological Bahaviour of Electro-Brush Plated Graphene Oxide - Nickel Nanocomposite Coated 316 Austenitic Stainless Steel

Shaojun Qi , Xiaoying Li, Hanshan Dong[1]

School of Metallurgy and Materials, University of Birmingham
Birmingham B15 1TT, UK
h.dong.20@bham.ac.uk

ABSTRACT

Nickel plating is a widely used cost-effective surface coating technology to protect steel surface from failure caused by wear and corrosion. However, the relatively high friction and low resistance to adhesive wear are major technical barriers to the use of nickel plating in some demanding applications.

In this research, graphene oxide (GO) has successfully introduced into nickel coating (NG05, NG20 & NG40) by an advanced electro-brush plating technique to form GO-Ni nanocomposite coatings on 316 austenitic stainless steel surfaces. For comparison, nano-graphite was also introduced in to nickel coating (NGr). In order to investigate the tribological behaviour of the GO-Ni nanocomposite coatings, reciprocating sliding wear tests were conducted against a steel ball of 8mm in diameter at room temperature in air under a load of 1-5N at a sliding speed of 5mm/s with a frequency of 1Hz. The friction force was recorded to calculate the coefficient of friction (CoF) and the wear was measured by a profilomter. Post-test characterisation of the wear track produced was carried out using SEM, EDX and FIB/SEM.

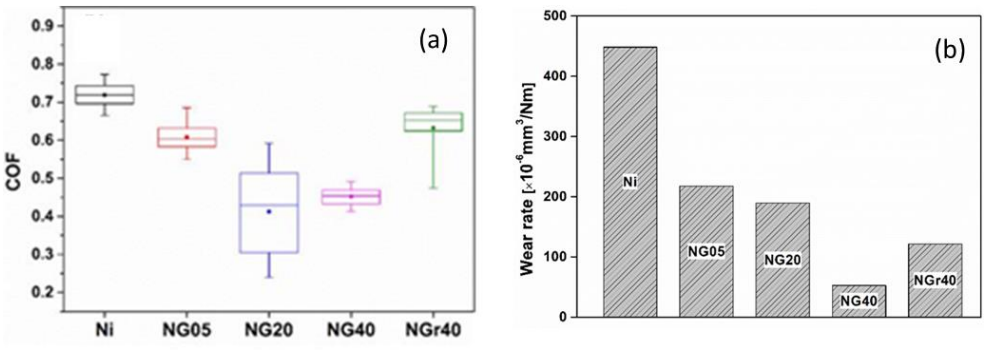

Fig. 1 CoF (a) and wear rate (b) of Ni, Ni-Go & Ni-Gr coatings

The results demonstrate that GO sheets incorporated into the nickel matrix can effectively improve the tribological behaviour of nickel coating in terms of reduced coefficient of friction (Fig.1a) and wear (Fig.1b). The significantly reduced CoF (from 07 for Ni to 0.4 for NG40) can be attributed to the formation of GO rolls observed on the wear surface, which changed the interaction from sliding to rolling. The drastically reduced wear rate (about 9 times lower than Ni) can be explained by the reduced Young's modulus to hardness ratio (E/H) from 23.8 for Ni to 18.6 for NG40, which reduced the plasticity and hence adhesive wear.

[1] Corresponding author & presenter