Al_2O_3 ir Al_2O_3-grafito dangų suformuotų plazminiu purškimu tribologinės savybės

The tribological properties of Al_2O_3 and Al_2O_3-graphite coatings deposited by plasma spraying

Jacob Shiby Mathew[1], Liutauras Marcinauskas[1,2], Mindaugas Milieška[2], Balakumaran Thanigachalam[3], Alja Kupec[4], Romualdas Kėželis[2], Ramūnas Česnavičius[3]
[1]Kaunas University of Technology, Department of Physics, Studentų str. 50, LT- 51368 Kaunas, Lithuania
[2]Lithuanian Energy Institute, Breslaujos str. 3, LT-44403 Kaunas, Lithuania
[3] Kaunas University of Technology, Department of Mechanical Engineering, Studentų str. 56, LT-51424 Kaunas, Lithuania
[4]Laboratory for Tribology and Interface Nanotechnology, Bogišićeva 8, 1000 Ljubljana, Slovenia
jacob.mathew@ktu.edu

Nowadays it is quite common to see degeneration of metallic surfaces arising from continuous use and is quite perilous [1]. Ceramic coatings have been widely used in industries for their inertness toward erosive environments, making them a potential candidate for anti-wear applications. Among the ceramic materials employed in plasma-sprayed wear-resistant coatings, alumina is widely used [2]. The properties of alumina coatings and composites depend pretty much on the process parameters and the chemical composition of feedstock powders [2-4]. The purpose of this study was to determine the tribological properties of Al_2O_3 and Al_2O_3-graphite coatings.

The coatings were deposited on stainless steel substrates using the technique of atmospheric plasma spraying [4]. Al_2O_3 and Al_2O_3-10 % graphite powders were used for the deposition. The flow rates of air and hydrogen were set at 4.7 g/s and 0.1 g/s, respectively. The torch powers were ~37.3, ~40.4 and ~43.1 kW. The surface morphology was examined using a scanning electron microscope (SEM) Hitachi S-3400N. The elemental composition of the coatings was determined by energy dispersive X-ray spectroscopy (EDS) Bruker Quad 5040 spectrometer. The surface roughness was measured using a Mitutoyo Surftest-SJ-210-Ver2.00 profilometer. Structural characterization of the coatings was carried out using X-ray diffractometry. The tribological properties of the samples were measured using a CETR-UMT-2 reciprocating-sliding ball-on-disc tribometer.

The surface roughness investigations indicated that in the case of Al_2O_3 coatings, with increase in torch power the surface roughness increased from 3.79 µm to 4.56 µm and with the incorporation of graphite, the variation was from 3.17 to 3.45 µm. It could be seen from the SEM images that with increase in torch power, the surface disorder had increased and with addition of graphite, sphere-like globules were formed. In the case of Al_2O_3 coatings, with increase in torch power it could be noticed from EDS measurements that the normalized atomic percentage of oxygen had increased from 54.3 at.% to 55.8 at.% and of aluminium from 32.3 at.% to 33.9 at.% whereas with Al_2O_3-graphite coatings, the oxygen content had varied from 31.8% to 35.9% and aluminium from 11.4% to 11.9%. The XRD measurements demonstrated that the dominant phase in the coatings was α-Al_2O_3.

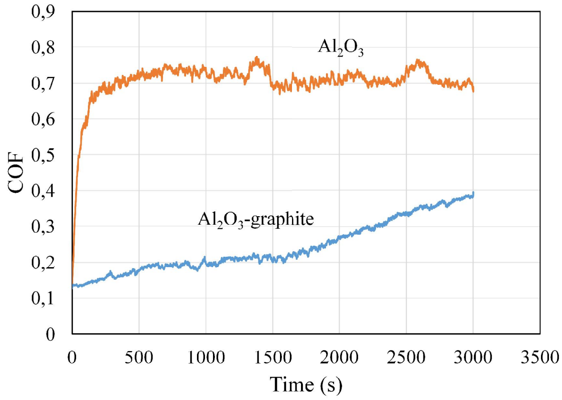

Fig. 1. Coefficient of friction measured at 0.8 N load.

Considering the tribological properties of Al_2O_3 coatings at 0.8 N load, the friction coefficient (COF) decreased from 0.746 (at ~37.3 kW) to 0.723 (at ~43.1 kW) and with addition of graphite, the COF increased from 0.383 (at ~37.3 kW) to 0.468 (at ~43.1 kW). In the case of Al_2O_3 coatings at 1 N load, the COF increased from 0.719 to 0.73 and with the incorporation of graphite, the COF also increased from 0.404 (at ~37.3 kW) to 0.519 (at ~43.1 kW). The normalized wear rate (NWR) of Al_2O_3 coatings at 0.8 N had decreased from 4.55 x 10^{-5} mm^3/Nm (at ~37.3 kW) to 3.88 x 10^{-5} mm^3/Nm (at ~43.1 kW) and with the addition of graphite, the NWR also decreased from 5.47 x 10^{-5} mm^3/Nm (at ~37.3 kW) to 2.41 x 10^{-5} mm^3/Nm (at ~43.1 kW). When load was taken at 1 N, with increase in torch power, the NWR had decreased from 1.23 x 10^{-4} mm^3/Nm to 8.17 x 10^{-5} mm^3/Nm, but with the incorporation of graphite, the NWR increased from 2.59 x 10^{-5} mm^3/Nm to a complete wear-out of the coating from the substrate.

Keywords: plasma spraying, alumina, coatings, tribological properties.

Reference

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