Wear and corrosion protective coatings produced by plasma electrolytic oxidation of aluminum alloys

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Abstract

Billions of dollars are wasted every year in the developed countries with problems associated to wear and corrosion or a combined effect of them. Oil production companies, for instance, expend more than 50 billion dollars due to corrosion of devices exposed to marine environments. Since, in a general way, ceramics are more chemically and physically resistant than metals, the coating of metallic surfaces by ceramic layers is a potentially effective way to avoid flaws. In this sense, alumina is an excellent candidate due to good barrier properties and high mechanical resistance. Alumina coatings can be produced by a multitude of techniques, including sol-gel, reactive sputtering, CVD and plasma spray. However, most of these techniques demand high temperatures to produce adherent and resistant coatings, which can represent a serious drawback, since the mechanical properties of most of the metals used in engineering are degraded by temperatures typically higher than 250-300$\circ$ C. In this context, Plasma Electrolytic Oxidation (PEO) can be considered as a very convenient alternative to produce ceramic coatings on metallic surfaces. In this work, an aluminum alloy (AA 5052) has been treated by PEO process with electrolytic solution of sodium silicate. The modified surfaces have been characterized by Scanning Electron Microscopy (SEM), Energy Dispersive Spectroscopy (EDS), Pin-on-Disc wear tests. The corrosion resistance has been evaluated through salt spray and Electrochemical Impedance Spectroscopy (EIS). SEM images evidenced that the coatings, with average thickness about 9.0 μm, are constituted by pores and nodules. As qualitatively determined by EDS, the porous regions have significant presences of Al and O, while the nodules are composed mainly by Si, O and Al. The results of wear tests revealed that the coatings borne a load at least to 13 times higher than the maximum pressure supported by the pristine alloy. Furthermore, the treatments enhanced in more than 140 times, as compared to the pristine alloy, the corrosion resistance time in salt spray exposures while EIS measurements revealed that the total system resistance increased up to 3 orders of magnitude.

Keywords: Protective coatings, plasma electrolytic processing

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