TRIBOLOGICAL BEHAVIOR OF AlN-ZrB2-BASED ELECTRIC-SPARK COATINGS

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INTRODUCTION

The peculiarity of new AlN-ZrB2 with small addition of ZrSi2 ceramics is a possibility of formation of Al2Si05 mullite and ZrSi04 zircon directly during gas-thermal and laser spraying, electric-spark alloying (ESA) due to high-temperature phase conversions under oxygen environment. The compounds above may play a positive role in corrosion as well as in tribological behavior as a solid lubricant. This is especially important for the problem of wear and corrosion-resistant coatings using in Space where there is no tribo-oxidation. Besides, under conditions of concentrated plasma fluxes the formation of fine-dispersion structure, improving the coatings working characteristics, take place. In this connection the goal of this study is to investigate the tribological parameters of ESA-coatings on both titanium alloy and steels using AlN-ZrB2-based ceramics electrode depending on the coating mass transfer kinetics, composition and structure.

METHODS

The working surfaces were investigated using metallographic, XRD, EPMA, and TEM method. The tribological characteristics were studied using “shaft-inset” scheme under dry friction in the range of 6 – 14 m/s sliding velocities. The resistance to high temperature oxidation was studied by thermogravimetric (TG) and differential thermal (DTA) analyses till 1200 °C in non-isothermal regime.

RESULTS

The tribological parameters (wear intensity and friction coefficient), structure and high-temperature corrosion as well as mass transfer kinetics of AlN-ZrB2-based ESA-coatings on different substrates (low-carbon steel, Cr-containing stamp steel, titanium alloy) were studied. Under ESA the fine-dispersion island-like coating structure is formed. The parts of sintered layer based on products of the electrode electro-erosion were on the surface of an alloyed crystallization zone. The grains size of sintered layer was 0.4 - 0.8 µm. The main phases of sintered layer on titanium alloy were ZrB2 and Al2O3. There were also as additives Al2SiO5, ZrSiO4, TiB2 and Ti3Al. The Ti-containing phases in a sintered layer were appeared due to Ti mass transfer from the substrate. The influence of both substrate material and coating phase composition on tribological behavior was ascertained. The increase of coating wear and friction under high impulses frequency when there were no mullite and zircon in the coating composition was shown. The ESA of titanium VT6 alloy (Al - 6%, V - 4%) as well as low-carbon steel decreases the friction coefficient till 0.13 and 0.15, and wear rate till 6 and 13.1 µm/km, respectively, Herein the working temperature of coated VT6 alloy was increased by 130 K. The resistance to high temperature oxidation of coated Cr-containing steel is increased by order compared with the initial steel.

The AlN-ZrB2-ZrSi2 composite material developed can be recommended for improvement of tribological and corrosion properties of high-performance alloys as a protective coating.