Multifunctional electrodeposited Ni-mullite composite coating

Meenu Srivastava, Suprita G.K, V K William Grips

Surface Engineering Division, Council of Scientific and Industrial Research – National Aerospace Laboratories, HAL Airport Road, Bangalore – 560017.

meenusri@nal.res.in

Abstract:

Nickel based composite coatings have attracted a lot of interest particularly for wear resistant and corrosion resistant applications. Among the various composite coatings Ni-SiC is of special interest as it is commercially used as wear resistant coating in rotary and reciprocating engines. However, at temperatures above 450°C SiC reacts with the nickel matrix to form brittle nickel silicide which deteriorates the performance of the Ni-SiC coating. Oxide particle reinforced nickel composite coatings can be an alternate to Ni-SiC coating as the distributed phase-oxides are thermally more stable compared to carbides. In the present study, mullite (3Al₂O₃.2SiO₂) particles have been reinforced in nickel matrix. The advantages of mullite include low thermal conductivity, excellent creep resistance, high-temperature strength, and good chemical stability.

The electrodeposition conditions were optimized to obtain maximum particle incorporation. The thermal stability of electrodeposited Ni-mullite coating in terms of microhardness was studied at temperatures upto 800°C and compared with Ni-SiC coating. The hardness value of as plated electroforms was similar for both Ni-mullite and Ni-SiC coating (400Hk). A marginal decrease in the microhardness of Ni-mullite coating occurred at temperatures of 600°C while, significant reduction was observed beyond 400°C for Ni-SiC coating. Thus, the incorporation of mullite particles in nickel matrix improves its thermal stability to a temperature of 600°C. The tribological studies showed that the wear volume loss for Ni-mullite coating is 2.38X10⁻⁵mm³/m while, that of Ni-SiC coating is 9.58X10⁻⁵mm³/m under identical testing conditions. The corrosion studies using potentiodynamic polarization and electrochemical impedance studies showed that the corrosion resistance of Ni-mullite coating is better than that of Ni-SiC coating. Thus, from the above studies it can be concluded that Ni-mullite has better wear and corrosion resistance compared to Ni-SiC coating in other words it is a multifunctional coating.