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Composite plating of aluminium—A direct method

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A direct method for composite coating of Ni/SiC on aluminium is described which consists of a minimum number of operating sequences such as degreasing, electrolytic etching in HCl, plating in a Watts nickel bath containing SiC suspension followed by a heat treatment. The pickling conditions were optimised and the effect of current density and SiC particle content in the bath on the vol. % inclusion of SiC in the deposit is studied. Results of hardness and wear rate of the deposit with respect to vol. % inclusion was discussed.

Key words: Composite coating, Ni/SiC composite, hardness, wear rate

INTRODUCTION

Anodised and electrodeposited coatings of aluminium find extensive application in architectural and functional areas. The invention of composite aluminium materials has explored the possibility of using them for automobile parts such as carburettors, piston rings, combustion engines and so on [1]. The replacement of steel by aluminium was made possible by the use of an electrolytic composite nickel-silicon carbide (Ni/SiC) coating which has better wettability than hard chromium and under comparative conditions an even better abrasion resistance than hard chromium [2]. In this investigation a direct coating method for plating on aluminium was described from a Watts nickel electrolyte containing SiC suspension. The effect of plating parameters were optimised and the hardness and wear resistance of the resulted deposits measured.

EXPERIMENTAL

The degreased 2S-aluminium specimen (5 × 7.5 cm) was cleaned in 10% sodium hydroxide solution at 315K, rinsed and electrolytically pickled in 5–15% hydrochloric acid (HCl), (anodic 10–15 secs followed by 40–60 secs cathodic) at 10–30 $A.dm^{-2}$, and again rinsed. Then plating was carried out in a Watts nickel bath and the plated samples were heat treated in a furnace kept at 473 K for 30 mins. Adhesion of the deposit was tested by bending the specimen to 180° and observed for peeling at bended portions. Based on the test, the optimum pickling conditions were chosen and further plating was carried out in the same electrolyte containing SiC suspension. The effect of particle concentration (5 to 100 $g\ dm^{-3}$) in the bath and current density (a range between 2 and 10 $A\ dm^{-2}$) on the volume percent (vol. %) inclusion of SiC in the deposit was studied systematically. The hardness of the deposit was measured using a Vickers hardness tester at a load of 100 g and the wear rate with a Taber abraser at a load of 1500 g using a CS-10 calibrase wheel. The surface morphology of the coated sample was studied using SEM.

RESULTS AND DISCUSSION

Based on the qualitative bend test it was concluded that anodic etching of 15 secs followed by 60 secs of cathodic treatment of aluminium in 10-15% HCl at 10-20 $A.dm^{-2}$ gave a porefree, semibright and adherent nickel deposit. In Fig. 1, it was clearly seen that the coating had broken at a few points due to severe bending and stretching, but it did not peel off the substrate showing a good adherence.

Fig. 1: SEM structure of bend test portion

Effect of SiC suspension and current density

As shown in Fig. 2, the vol. % inclusion of SiC in the deposit increased gradually from 3% to 13% for a concentration range of 5-100 $g.dm^{-3}$ in the bath. The uniform distribution of SiC particle in the Ni matrix was seen in Fig. 3. At higher particle concentration due to insufficient stirring to keep them in suspension, a rough and segregated deposit was obtained and the inclusion attains a steady value.

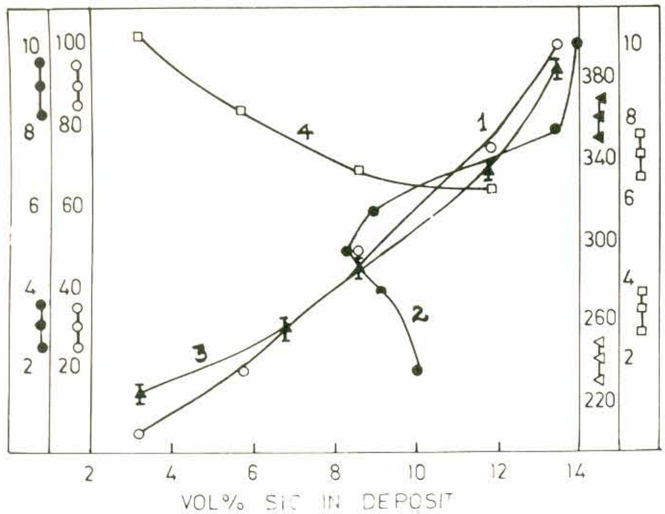

Fig. 2: Effect of SiC inclusion on C.D., hardness and T.W.I.
o – o – o *SiC particle in the bath g.dm^{-3}*
• – • – • *Current density, A.dm^{-2}*
▲ – ▲ – ▲ *Hardness, VHN$_{100}$*
□ – □ – □ *Taberwear index (TWI$_{1500}$)*

Even though the effect of current density variation was not so marked, the deposit obtained at 4 to 6 A.dm^{-2} was uniform with a fine grained deposit structure.

As shown, in Fig. 2 the hardness and wear resistance of the composite deposit increases with SiC inclusion. The presence of uniformly dispersed fine SiC particles obstruct the easy movement of dislocations under the applied load

Fig. 3: SEM structure of Ni-SiC (13 Vol %)

and resists the plastic flow of material. As a result, the deposit shows greater resistance to deformation and hence a higher hardness and wear resistance.

CONCLUSION

The method described gives an adherent deposit of Ni/SiC composite on aluminium which possesses high hardness and wear resistance as required for automobile applications.

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