Chapter 5

CONCLUSIONS

5.1 INTRODUCTION

The present study has covered three main aspects of electrodeposited black coatings on lock nut and radiator pin plug. The first and third aspects are chiefly concerned with studies of mechanical properties of black coatings obtained from trivalent chromium electrodeposition and modified black phosphate conversion coatings. The second one is on the development of high speed black coatings obtained by electrodeposition of ternary alloys of Ni-Cu-Co and Ni-Zn-Co black coatings besides mechanical properties.

5.2 SUMMARY OF CONCLUSIONS

The major conclusions drawn from the above studies are presented below:

1. A new bath formulation based on trivalent chromium as an alternate to hexavalent chromium plating process has been formulated and found stable throughout the experimental conditions. This coating on mild steel components improved the mechanical properties.

2. Various plating bath parameters such as metal ion concentration, additives, pH, temperature, plating time and current density have been optimized to have the deposit on metallic components made of mild steel.

3. For high speed black coatings, nickel based ternary alloys systems have been identified and explored in detail. The coatings obtained from this plating formulation could be useful to deposit black uniformly on any regular shaped metallic components with improvement in mechanical properties.

4. The modified black phosphate coatings with enhanced mechanical and optical properties have been developed successfully involving molybdenum metal as a nucleation center to intensify the appearance of black colour through the effective formation of iron molybdate on the surface of mild steel components.

5. The weight gain studies, potentiodynamic polarization, a/c impedance and absorption coefficient measurement were the techniques adopted for evaluation of mechanical properties of coatings.
6. The decreased $R_t$ and increased $C_{dl}$ values obtained from the impedance measurement confirm the corrosion resistance of the coatings on mild steel components.

7. Hardness and abrasion resistance measurements have been made for the evaluation of mechanical properties of the deposits along with electrochemical studies and salt spray test for the corrosion resistance properties.

8. All the above coatings on mild steel components were found to enhance the hardness and abrasion resistance both in the as plated as well as annealed conditions except black phosphate coatings.

9. A reciprocal correlation exists between the hardness and abrasion resistance of black phosphate coatings on steel components explained due to the presence of soft molybdenum particles in the coating.

10. All the developed black coatings on mild steel components are found to have good corrosion resistance properties.

11. The XRD studies confirm the presence of intermetallic phases which is further facilitated after annealing through the precipitation hardening mechanism of metallic atoms in the black coatings.

12. The SEM studies reveal the surface morphology of black coated steel substrates and justified that presence of pores and voids are meager in all black coatings which are responsible for the higher abrasion and corrosion resistance.

13. XPS analysis demonstrated the oxidation states and nature of individual atomic species exist in the black coatings evidenced from the binding energy values.

14. Atomic absorption spectral results confirmed the weight percentage of metals present in the coatings.

The electrodeposition of black coatings based on trivalent chromium, high speed nickel ternary alloys and phosphate coatings a subject of recent interest on automobile components owing to many of its commercial applications.
5.3 SCOPE OF THE FUTURE WORK

1. The composite coatings based on silicon carbide, tungsten carbine, silicon nitride, graphite etc. on black electro/ electroless deposition can be investigated for naval/ automobile components.

2. Development of black coatings with improved tensile properties for aerospace aluminium alloys are to be studied.

5.4 CONTRIBUTION TO THE LITERATURE

This research work provides a contribution to the literature in the development of non-toxic black trivalent chromium electrodeposition on mild steel components with improved mechanical properties which is the recent interest in the automobile industries with addition to its superior corrosion resistance property. The development of high speed electrodeposition method based on nickel alloys with the rate of deposition of more than 30 microns per hour have been developed with enhanced mechanical properties to improve the industrial production process. The development on modified black phosphate coatings can also be employed as a pretreatment layer before laser heat-treatment, which increases the efficiency of light-absorption during laser heat-treatment.
International Journal Papers published based on the research work


Patent filed based on the research work