ABSTRACT

Near spherical shaped nanocrystalline ceria (CeO_2) powders (30-36 nm) have been prepared by high energy ball milling (HEBM) of plate shaped as-received CeO_2 powders. The Rietveld analysis, classical Williamson-Hall method (WH) and modified Williamson-Hall method (MWH) have been used to determine the average crystallite size. The MWH method indicates that mostly edge dislocations are present in the CeO_2 powders.

The effect of different pulse electrodeposition parameters, such as, the amount of surfactant sodium lauryl sulphate (SLS) and additive sodium saccharin (SS), current density, bath temperature, duty cycle, and stirring rate on the co-electrodeposition of the nano-sized CeO2 particles in the Ni matrix have been studied. Then, Ni–CeO_2 nanocomposite coatings with different concentration of CeO_2 have been pulse electrodeposited (PED) from a Watts-type electrolyte containing ball milled CeO_2 powders (10, 20, 30, 40 and 50 g/l). The microstructural characterization reveals that the Ni-CeO_2 composite coating with the smallest crystallite size and highest hardness can be obtained when it is deposited from the electrolyte containing 30 g/l CeO_2.

The thermal stability of the coatings is evaluated by DSC analysis and isothermal annealing. It is found that the thermal stability of the composite coatings is higher than that of the pure Ni coating. The Ni–CeO_2 coating, deposited from the electrolyte containing 30 g/l CeO_2, has the highest thermal stability among all the composites studied here. The corrosion resistance and electrical resistivity of the composite coating, deposited from the electrolyte containing 30 g/l CeO_2, are also the highest. The wear resistance of the pure Ni and Ni–CeO_2 (deposited from the electrolyte containing 30 g/l CeO_2) coatings have been evaluated using a WC ball or diamond pin indenter and it is found that the wear resistance of the composite coating is better than that of the pure Ni coating. The scratch test results also show that the scratch resistance of the composite coating is better than that of the pure Ni coating.

Keywords: high energy ball milling; pulse electrodeposition; nanocomposite coating; microstructure; hardness.