DEVELOPMENT OF NiCrSiB COATING ON AISI 304 STAINLESS STEEL FOR HOT CORROSION RESISTANCE AND La_2O_3-YSZ COMPOSITE COATING ON INCONEL 718 FOR THERMAL BARRIER APPLICATIONS

Abstract

The present work aims at detailed investigation of (a) NiCrBSi (68.4Ni-17Cr-3.9B-4.9Si-5.8Fe) coating on AISI 304 stainless steel (C: 0.08%, Cr: 18%, Fe: 66%, Mn: 2%, Ni: 8%, P: 0.04%, S: 0.03%, Si: 1%) for improving hot corrosion resistance of AISI 304 stainless steel and (b) La_2O_3-YSZ composite thermal barrier coating for improving high temperature oxidation resistance of INCONEL 718 (Ni-18.8Fe-14Cr-7.3Nb-1.7Mo-1.3Ti-0.7Al) by thermal spray deposition technique. Thermal spray deposition of nickel based hard faced alloy (68.4Ni-17Cr-3.9B-4.9Si-5.8Fe) has been carried out on sand blasted AISI 304 stainless steel by flame spraying and high velocity oxy-fuel (HVOF) spraying techniques for hot corrosion resistance application. A detailed microstructural investigation of flame sprayed layer shows the formation of γ-Ni and refined Ni_3B precipitates. HVOF spraying leads to development of microstructure consisting of dispersion of Ni_3B and Cr_2B in partially amorphous γ-Ni matrix. Attempts were also made to melt the near surface region of HVOF spray deposited surface and understanding its effect of microstructure and properties. A detailed study of wear behavior shows that combined HVOF spraying and laser surface melting offer a maximum improvement in wear and corrosion resistance properties. The hot corrosion behavior of thermal spray deposited AISI 304 stainless steel with NiCrBSi has been studied in a 70%Na_2SO_4+30%NaCl molten salt media in the temperature ranges between 700 $^{\circ}$C to 900 $^{\circ}$C by cyclic test with total number of 18 cycles of heating and subsequent air cooling. Detailed studies of the properties of coating developed by flame spraying and HVOF spraying show that HVOF spraying of NiCrBSi develops a denser coating with a lower defect density, and better adherence than flame spraying. The appropriate reaction and mechanism of degradation of as-received and NiCrBSi coated AISI 304 stainless steel is evaluated in a salt mixture of 70 wt.% Na_2SO_4 and 30 wt.% NaCl.

In another effort, an innovative initiative on the development of composited TBC consisting of a mixture of La_2O_3 and YSZ (with a maximum of 50 mole % La_2O_3) has been applied on CoNiCrAlY bond coated INCONEL718 substrate. The bond coating was deposited by high velocity oxy-fuel spraying technique prior to plasma spraying of ceramic top coating. The performance of the coating has been evaluated in terms of high temperature oxidation resistance (under both isothermal and cyclic condition) at temperatures ranging from 900 $^{\circ}$C -1000 $^{\circ}$C. There is a marginal improvement in isothermal oxidation resistance and a significant improvement in cyclic oxidation resistance with addition of La_2O_3 in the La_2O_3-YSZ

composite TBC. The mechanism of failure of the top coating has been evaluated by a detailed analysis of the oxidized surface after cyclic oxidation, The enhanced cyclic oxidation resistance and reduced failure rate of the La_2O_3-YSZ composite TBC coatings as compared to conventional YSZ coating is attributed to (a) reduced growth kinetics of TGO between bond coat and top coat, (b) increased sintering resistance of top ceramic coating due to La_2O_3 addition in conventional YSZ, (c) reduced in-plane tensile residual stress on the top coat surface and (d) reduced thermal expansion mismatch between TGO (Al_2O_3) layer and ceramic top coat.