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Effect of sol-gel processing on microstructural features and oxidation mitigating properties of mixed nanocrystalline rare earth oxides

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Rare earth (RE) oxide sols of CeO2, Nd2O3, Pr2O3, La2O3, CeO2 + La2O3, CeO2 + Pr2O3, CeO2 + Nd2O3, Pr2O3 + La2O3 and Nd2O3 + La2O3 were prepared as aqueous dispersions of the respective RE oxides with nitric acid, and a non-ionic surfactant. Two processing routes were used to prepare the mixed RE oxide sols. Route-1 consisted of preparing separate sols of two RE oxides followed by mixing of the sols in the proportion 50:50. In Route-2 the RE oxides were mixed first in the same proportion and then a sol of the mixture prepared. The sols and the mixture of sols were heated to 150 ?C in air to form the respective oxide gels. The morphology, particle size, crystallite size of the different RE oxides as well as the effect of coatings of these RE oxides on the oxidation behavior of Fe20Cr5Al alloys at 1100 °C was determined. The crystallite sizes of the different RE oxides were determined by x-ray diffraction analysis and found to vary from 25-65 nm. The morphology of the RE oxides of Ce, Pr and Nd were cubes, cuboids and fine needles. The isothermal oxidation behavior of uncoated and coated specimens was studied with a thermogravimetric analyzer. Overall, the individual oxides decreased oxidation rate. However, the CeO2 + Nd2O3 mixture did not increase oxidation resistance of the alloy further, compared to those with either one of these two RE oxides. The Pr2O3 + CeO2 mixture increased oxidation resistance of the alloy significantly, whereas the mixture Nd2O3 + Pr2O3 had no noticeable effect. Mixed oxides prepared by Route-1 was more effective in increasing alloy oxidation resistance compared with those prepared using Route-2. The differences in the influence of a specific rare earth oxide or a mixture are attributable to differences in the ionic radii of the RE and the morphology, coverage as well as crystallite sizes of the RE oxides.