Novel In-Situ Transformable Coating for Elevated-Temperature Applications

D.J. Branagan, J. Zhou, J.K. Walleser, B.E. Meacham, and B.D. Merkle

Abstract

A novel glass forming twin wire-arc thermal spray coating material, SHS 8000, has been developed which is applicable to elevated temperature environments involving erosion and corrosion. When sprayed using conventional twin wire-arc spray technology, primarily amorphous coatings are obtained containing an amorphous matrix with very small nanocrystalline precipitates that are less than 10 nm in size. The as-sprayed coatings are found to be very hard and abrasion resistant. However, during elevated temperature exposure such as in coal-fired or biomass boiler environments, the coating may devitrify into a full nanocrystalline state consisting of α-Fe and $M_2(BC)_1$ phases. When this occurs the microhardness is found to increase dramatically by over 200 kg/mm^2 which leads to an increase in abrasion resistance by a factor of 3.5 with an analogous increase in erosion resistance. Due to the significance of these beneficial changes in coating behavior, the kinetics of the devitrification transformation was investigated using isothermal experiments and modeled with classical nucleation theory. Predictive behavior was then enabled through the development of a Time-Temperature-Transformation diagram to model the devitrification transformation under specific thermal exposures, which was additionally confirmed by experimentation.