MICROSTRUCTURAL EFFECTS ON THE OXIDATION OF IRON ALUMINIDE

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An Abstract of a Thesis Submitted to the Graduate

Faculty of Rensselaer Polytechnic Institute

in Partial Fulfillment of the

Requirements for the Degree of

DOCTOR OF PHILOSOPHY

Major Subject: Materials Science and Engineering

The original of the complete thesis is on file
in the Rensselaer Polytechnic Institute Library

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Troy, New York

July 2007
(For Graduation August 2007)

ABSTRACT

This work addresses the impact of processing and microstructure on the oxide chemistry and short–term isothermal oxidation rate, over the first 24h of oxidation, for the B2 iron aluminide, Fe–40Al. Research interests in iron–aluminum alloys, used for high temperature structural applications, are primarily concerned with the improvement of high temperature oxidation performance and mechanical properties. The oxidation performance of alloys with aluminum contents below 20at% is dependent upon processing and microstructure. Before this work, it was not established if there was any impact of material processing and microstructure on the oxidation performance of the high aluminum content Fe–40Al alloy.

This study utilized eight industrial processes to produce six different material conditions. Among the characteristics of the microstructures produced were grain sizes from 2 to $\geq$500μm, oxygen contents from 0 – 2.6at%, and powder particle surface area–to–volume ratios from 0 – 0.6m^2/cm^3.

For the six materials tested, short–term (24h) isothermal oxidation rates were determined at 700, 750, and 800^{o}C. The resultant rates were then used to determine the relationship between the oxidation rate constant and temperature. The chemistry, physical characteristics, and structure of the oxides formed were then characterized.

It was concluded that microstructure has a limited impact on oxidation properties: no practical impact was observed on oxidation rate; an initial transient oxide layer formed independent of microstrucure; microstructure can be used to control the formation of oxide–metal interfacial voids, formed during the oxidation process; and oxide inclusion "pegs" serve to improve oxide adhesion. Additionally it was observed that contamination from hot pressing contributed to the formation of oxide nodules during oxidation. Overall the isothermal oxidation properties during the first 24h of exposure proved to be robust over many combinations of microstructures.