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ABSTRACT

The Fe-Al alloys have been viewed as attractive for applications in the energy sector, for example boilers and pipes in power plants. As such, improvement of the properties of an Fe-40 at.% Al alloy were attempted by adding small amounts of precious metal to the alloy. An Fe-40 at.% Al alloy produced by melting and casting in a button arc furnace, showed very large grains in the microstructure and had a hardness of ~400HV. Precious metals (Ag, Ru, Pt, Pd) were added in amounts of either 0.2 at.% or 0.5 at.%. Additions of Ag and Ru were found to decrease the hardness, but the addition of Pt and Pd did not affect the hardness significantly. Oxidation testing of the alloys showed that they were very resistant to oxidation, although there was some small internal oxides in the sample containing Pt. Corrosion testing of the samples showed that the precious metals helped to greatly decrease the corrosion rate of the FeAl alloy in H_2SO_4.

The mechanical alloying and sintering parameters were first optimised using the plain FeAl alloy and the sintered plain FeAl had significantly smaller grains than the as-cast material under all conditions, and that the hardness had increased as a result. The mechanical alloying also produced a carbide phase in the material that was not able to be removed.

After mechanical alloying and sintering of the precious metal containing alloys, the microstructure had been refined slightly more than plain FeAl in all the alloys, except that containing Ru, which was the same as the plain alloy. The presence of Pt and Pd increased the hardness of the alloy slightly, while Ru and Ag produced no change.

Oxidation testing showed that the sintered compacts had significantly less grain growth than the as-cast samples, and that generally the oxidation resistance was good. The exception to this was the sample containing Pd, which showed sub-surface oxidation. Corrosion testing of the sintered compacts showed that the Ru and Pt containing alloys performed better than the as-cast alloys. Both the Pd and Ag containing samples suffered from pitting, and the Pd sample was corroded away completely during the test in 3.8M H_2SO_4 solution.

It was concluded that there was a significant effect on the microstructure of the FeAl alloy due to the processing route used, and that this also produced a significant effect on the hardness and corrosion resistance, with both improving when non-equilibrium processing was used. The presence of precious metals in small amounts increased the corrosion resistance of the alloy, and overall, only produced small changes in the hardness, and oxidation properties of the alloy.