Influence of Y_2O_3 and Fe_2Y additions on the formation of the nano-scale oxide particles and Charpy impact properties of an ODS RAF steel

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Abstract

The main goal of this work is to develop an oxide dispersion strengthened (ODS) reduced activation ferritic (RAF) steel from pre-alloyed, gas-atomised Fe-14Cr-2W-0.3Ti (wt%) powder mechanically alloyed with two kind of particles, yttria (0.3%Y_2O_3) nano-particles (20 nm) and 0.5%Fe_2Y intermetallic compound particles (<45μm) consolidated by Hot Isostatic Pressing (HIPping). The nano-scale complex oxide particles, particularly size, number density and structure have an influence on the mechanical strength, thermal and creep stability and irradiation resistance of ODS steels.

It was found that the different kinds of particles have no influence on the powder morphology and general microstructure of both ODS alloys after MA and HIPping. As expected, lower oxygen contents were measured for ODS Fe_2Y material. This indicates that the use of Fe_2Y intermetallic particles can reduce the oxygen content in the ODS steel powder what may have an influence on the mechanical properties, especially fracture resistance, of the ODS alloys. Transmission Electron Microscopy (TEM) observations showed, however, that the nano-clusters of Y-Ti-O are larger in size and with lower volume fraction in the case of the ODS Fe_2Y alloy. On the other hand, Charpy impact properties of this material, a ductile-to-brittle transition temperature (DBTT) and upper shelf energy (USE), was significantly better (DBTT= -25°C, USE=8.8 J) in comparison with ODS Y_2O_3 material (DBTT=90°C, USE=2.5 J). This is probably due to lower oxygen content and differences in the dispersion morphology, size and chemical composition revealed in this alloy in comparison with ODS Y_2O_3 one.