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Precipitation of Y-Ti-O nanoparticles during the HIP consolidation of gas atomised powders

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The increase in the operational temperature range of structural materials plays an important role in most demanding energy generation sources and in certain industrial processes since it enhances the efficiency and promotes a reduction of the environmental pollution. In this sense, oxide dispersion strengthened ferritic stainless steels (ODS FS) are candidate materials for structural components in future fusion and fission reactors, concentrated solar power plants, chemical reactors or advanced coal fired plants. Their high strength and creep resistance at elevated temperatures, and good resistance to neutron radiation damage is obtained through a high density of nanometric complex oxides, generally rich in yttrium and titanium, very stable thermodynamically.
In this work, the powder metallurgy route named STARS (Surface Treatments of gas Atomized powder followed by Reactive Synthesis) is applied to produce ODS FS with composition Fe-14Cr-2W-0.3Ti-0.3Y2O3 (wt.%). The gas atomized powders already contain the oxide-dispersion formers, so mechanical alloying is no necessary to dissolve yttrium in the ferritic matrix. Then, a metastable oxide layer, mainly consisting of Cr2O3 and Fe2O3, develops at the surface of powder particles. Consolidation by HIP at high temperature promotes the dissociation of the metastable oxides, the subsequent oxygen diffusion towards the interior of the particles and the final precipitation of Y-Ti-O nanoparticles. The process finishes with a thermo-mechanical treatment performed to refine and homogenize the microstructure and improve the mechanical properties
Microstructural characterization of powders and consolidated and thermo-mechanically treated samples performed by XPS, SEM, TEM, and X-ray absorption spectroscopy (XAS) is presented and correlated with manufacturing parameters.

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Materials

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