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P3.207 Microstructural comparison of Oxide-Dispersion Strengthened Ferritic Steels produced by HIP and Spark Plasma Sintering

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The high mechanical strength of ODS FS, and their resistance to creep and neutron radiation damage up to 750 °C are attributed to extremely fine microstructures with high density of very stable nanometric precipitates, generally Y-Ti-O oxides. The STARS route (Surface Treatment of gas Atomized powder followed by Reactive Synthesis) proposed by Ceit avoids mechanical alloying to introduce yttrium in atomized prealloyed powders. Powders containing yttrium are atomized and oxidized to grow a thin metastable Cr-, Fe-rich oxide layer on the surface of particles. During HIP consolidation at high temperature, oxides at Prior Particle Boundaries (PPBs) dissociate, oxygen diffuses towards titanium and yttrium, and Y-Ti-O nanoparticles precipitate.
Once the feasibility of the STARS route has been validated, two strategies are proposed in this work to enhance precipitation of nanoparticles and improve the mechanical strength. Firstly, consolidation by Spark Plasma Sintering (SPS) is evaluated to produce finer microstructures compared to HIP consolidation. SPS parameters like temperature, heating rate, pressure and time of exposure under pressure were explored using spherical powders, and dense samples (>99,5 %RD) were obtained.
Secondly, a profuse precipitation of nanoparticles is achieved through a combination of HIP consolidation at low temperature (700-900 °C) followed by hot deformation under the presence of metastable oxides, to increase the density of dislocations. These dislocations are preferential nucleation sites for the precipitation of nanometric Y-Ti-O oxides during final heat treatment at high temperature (>1200 °C). Deformation dilatometry and plane strain compression tests were performed to simulate hot deformation under different hot rolling schedules. Total deformation, number of passes, time between passes or initial and final rolling temperatures are some of the parameters explored.
Microstructural characterization by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM) of consolidated materials is presented and correlated with mechanical behavior.

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