# Microstructural characterization of the ODS Eurofer 97 EU-batch

R. Mateus[1], P.A. Carvalho[1,2], D. Nunes[1,3], L.C. Alves[4], N. Franco[4], J.B. Correia[3], E. Alves[4]

*[1]Associação Euratom/IST, Instituto de Plasmas e Fusão Nuclear – Laboratório Associado, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal*
*[2]ICEMS, Departamento de Engenharia de Materiais, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisboa, Portugal*
*[3]LNEG, Departamento de Materiais e Tecnologias de Produção, Estrada do Paço do Lumiar, 1649-038 Lisboa, Portugal*
*[4]ITN, Instituto Tecnológico e Nuclear, Estrada Nacional 10, 2686-953 Sacavém, Portugal*

*Corresponding author: rmateus@ipfn.ist.utl.pt*

Eurofer 97 and the other reduced activation ferritic/martensitic (RAFM) steels have been developed for fusion reactor applications. The materials design has been aimed at enhancing specific properties, namely tensile strength at moderate temperatures as well as swelling and creep resistances. In oxide dispersion strengthened (ODS) RAFM steels, the oxide nanoparticles tend to retard grain growth through a boundary pinning effect, which improves the system thermal stability and allows extending the working temperature. In the European Union, ODS RAFM research has been essentially focused on Eurofer 97 reinforced with $Y_2O_3$. Nevertheless, in spite of superior strength, thermal stability and irradiation resistance, the impact behaviour and the ductile-to-brittle transition temperature of ODS Eurofer 97 still require enhancement, which may be achieved by suitable thermomechanical processing.

In the present study four as-processed forms (Plate 16, Plate 6, Rod 20 and Rod 12.5) of the ODS Eurofer 97 EU-batch produced under different thermomechanical conditions have been investigated by scanning nuclear microprobe, scanning and transmission electron microscopy, energy dispersive X-ray spectroscopy, electron backscattered diffraction, high-temperature X-ray diffraction and microhardness measurements. The materials presented a homogeneous distribution of Y in a ferritic microstructure decorated with carbide precipitates. The thicker plate presented a fine carbide dispersion while the other forms presented carbide morphologies corresponding to pseudo-pearlitic and pseudo-bainitic transformations with well-matched hardness values. Hot rolling induced crystallographic textures of the $\{101\}\langle 10\bar{1}\rangle$ type, rotary swaging resulted in a complex texture, whereas extrusion produced a strong $\langle 101\rangle$ fiber texture. X-ray diffraction experiments at high temperature showed that at a cooling rate of 5 ºC/min the complete diffusive transformation of austenite into ferrite occurs between 760 and 750 ºC compromising the material hardenability.