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CHARACTERIZATION ON NANOSIZED OXIDES IN THE 14wt%Cr OXIDE DISPERSION STRENGTHENED STEEL

Yael Templeman[1], Denis Sornin[2], Malki Pinkas[3] and Louisa Meshi[1]

[1] Department of Materials Engineering, Ben Gurion University of the Negev, POB 653, Beer Sheva 84105, Israel.
[2] CEA, DEN, SRMA, LTMEx, 91191 Gif-sur-Yvette, France.
[3] Nuclear Research Center-Negev, P.O. Box 9001, Beer-Sheva, Israel.

Oxide dispersion strengthened (ODS) steels are promising candidates for cladding tubes` materials in the next generation nuclear power plants. This application requires service under harsh conditions involving prolong exposure to neutron irradiation at high operating temperatures, which cannot be applied on the conventional reduced activation ferritic martensitic (RAFM) steels. The reinforcement of highly dispersed oxide nanoparticles throughout the matrix, provides ODS steels with exceptional strength and creep resistance at high temperatures. The addition of Ti to these alloys reduces the particle size, leading to higher dispersion of fine Y-Ti-oxide particles. These oxides block mobile dislocations, resulting in increased hardness and strength. In addition, the interfaces between the oxides and the matrix act as sinks for point defects, such as vacancies and He bubbles induced by neutron irradiation, thus minimizing the degradation of the mechanical properties. Although numerous studies were conducted in order to characterize these oxides, ambiguity regarding their composition and structures still remains. The most common types of such oxides which were reported to exist in these steels are $Y_2Ti_2O_7$ and Y_2TiO_5 [1]. However, many researchers claimed that these oxides are composed of non-stoichiometric Y-Ti-O-enriched clusters [1], and reports on core-shell structures can also be found [2]. The properties of the final product are affected dramatically by the structure, composition, size and distribution of these nanosized oxides. Therefore, characterization of these parameters is crucial. In the present study, detailed TEM analysis, including HAADF, EFTEM and EELS, was conducted in order to determine the distribution, composition and structure of oxide particles in a 14wt% Cr ODS alloy. It was found that oxides are composed mainly of Y, Ti and O, and that between most measured particles the Y/Ti ratio was neither 1 nor 2. Diffraction patterns obtained from these particles could not been indexed in terms of the $Y_2Ti_2O_7$ or Y_2TiO_5 structures. Some patterns were attributed to the $YTiO_3$ (distorted perovskite derivative), which is rarely reported in the literature. Others belong to a structure which was not reported neither in binary nor ternary Y-Ti-O systems.

References:

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