DE LA RECHERCHE À L'INDUSTRIE

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Séminaire

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Interface stability under irradiation in Oxide Dispersion Strengthened steel

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Oxide Dispersion Strengthened (ODS) ferritic steels are considered as promising candidates for nuclear application as cladding tubes for GEN IV reactors. In such reactors, the irradiation damage can reach more than 150 dpa at temperatures ranging between 400°C and 650°C. Thus, the stability of nano-particles has to be guaranteed in order to ensure the materials' excellent properties.

Using Fe ions, ODS steels were irradiated at 500°C up to 237 dpa. Under these conditions, the system evolution consists in a density fall and a increase of the nano-particle size, plus an evolution of the stoichiometry toward the $Y_2Ti_2O_7$ equilibrium composition with Cr rejection. It is proposed a radiation-induced Ostwald ripening process.

Although nano-particles are driven to equilibrium, under irradiation, where a forced dynamics produced by the external forcing is competing with a thermally activated dynamics, interfaces could be sustained far from equilibrium. In order to assess the interface stability, the orientation relationships between particles and matrix are first identified out of irradiation using HRTEM. Cube-on-cube and cube-on-edge orientations are reported. These coherent misfitting interfacial configurations conduct the interfaces to grow under elastic stress effect at the origin of their smooth and flat morphology. After irradiation, same interfaces appear as destabilized since they display morphological changes or diffusenesses that are discussed in both terms of nonequilibrium roughening and faceting. From a practical and applied point of view, the modification of precipitate shapes under irradiation may alter their growth and even conduct to a coarsening saturation, able to modify the mechanical response of the irradiated alloy. Further, interface instability is also susceptible to influence the interaction between nano-particles and point defects. The behaviour of the point defects in the close vicinity of incoherent, semicoherent and coherent interfaces is inferred by observing the formation of Kr-stabilized cavities attributed to the condensation of vacancies in excess concentration.