Effects of Aluminum Contents on High-Temperature Strength of 9Cr-ODS Martensitic Steel


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The 9Cr-oxide dispersion strengthened (9Cr-ODS) steel is a prospective material for fusion reactor blanket as well as fuel cladding tube of advanced sodium-cooled fast reactor (SFR). In ODS steels, aluminum (Al) contamination is known to degrade the extent of oxide dispersion strengthening and provide considerable deterioration of high-temperature strength, while Al is often used for improvement of corrosion resistance. This study investigates the effects of Al addition on high temperature strength of the 9CrODS steel with a view to displaying the quantitative correlation between Al concentration and mechanical property and showing the threshold Al concentration to keep satisfactory strength. The 9Cr-ODS steel bars with different Al concentration from 0.03 to 0.15 wt% were produced by mechanical alloying and a subsequent hot-extrusion at 1,423 K, where Fe- 9wt%Cr-2W-0.2Ti-0.35Y2O3 was chosen for basic chemical composition. Elemental powders and yttria powders were used as raw material powders for the MA. Uni-axial tensile tests were performed at temperatures from R.T. to 1,073 K with load parallel to extrusion direction. Microstructures were characterized by field-emission type transmission electron microscope (TEM) and optical microscope. Aluminum addition over 0.05 wt% has apparently degraded the tensile strength. TEM observation indicated that size of nano-sized oxide particles coarsens with increasing Al concentration. Although Al is a strong ferrite-forming element, its addition has unexpectedly decreased the fraction of ferrite phase that is considered to improve high-temperature strength of the 9Cr-ODS steel. In the presentation, role of Al in mechanical property of the 9Cr-ODS steel will be discussed from the viewpoint of oxide particle distribution and type of matrix phase.