1.1 Effects of Alloying Elements and Thermochemical Treatment on 9Cr Reduced Activation Ferritic-Martensitic (RAFM) Steels — L. Tan, Y. Yang and J.T. Busby (Oak Ridge National Laboratory)

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RAFM steels are one of the candidate structural materials for fusion reactors, in which tantalum (Ta) and tungsten (W) are alloyed to replace niobium (Nb) and molybdenum (Mo) in conventional FM steels, respectively. This paper, using three RAFM heats, presents the effects of Ta and the primary austenite stabilizer carbon (C) on microstructure and strength. Thermomechanical treatment (TMT) was applied to the experimental heats, leading to significant increases in strength, attributable to the TMT-refined sub-grains and precipitates. The Ta-alloying favored the formation of (V,Ta)(N,C) and (Ta,V)C, which exhibited greater strength. Fractographic analysis together with microstructural characterization revealed the beneficial effects of TMT and Ta-alloying. However, extra C content, favoring a larger amount of $M_{23}C_6$ precipitates, did not show strengthening effect.

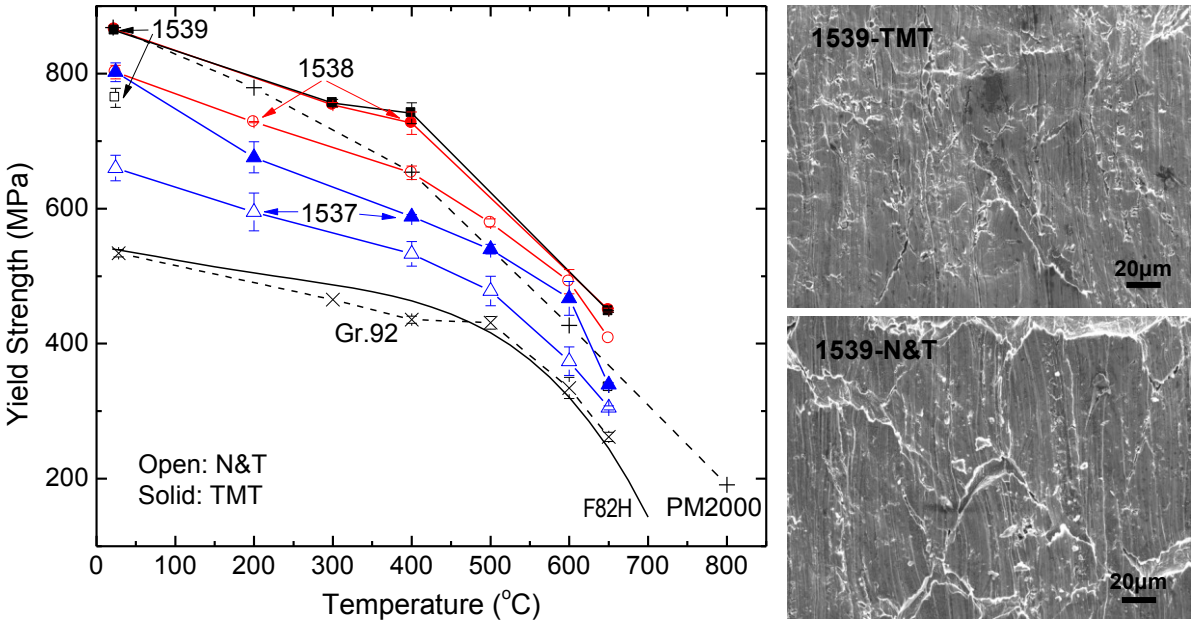

Figure 1. Yield strength of heats 1537, 1538, and 1539 in the conventional normalization and tempering (N&T) and TMT conditions, compared to the literature data of Grade 92, F82H, and ODS steel PM2000. Triangles, circles, and squares denote the samples of 1537, 1538, and 1539, respectively. The SEM images, using heat 1539 samples in the N&T and TMT conditions as examples, show the side surface morphologies close to the necking area of the tensile-fractured samples tested at room temperature with the loading axis along the vertical direction of the images.