3-10 Further Improvement of the Fusion Reactor Structural Material
—Inclusion Control in Reduced Activation Ferritic/Martensitic Steel F82H—

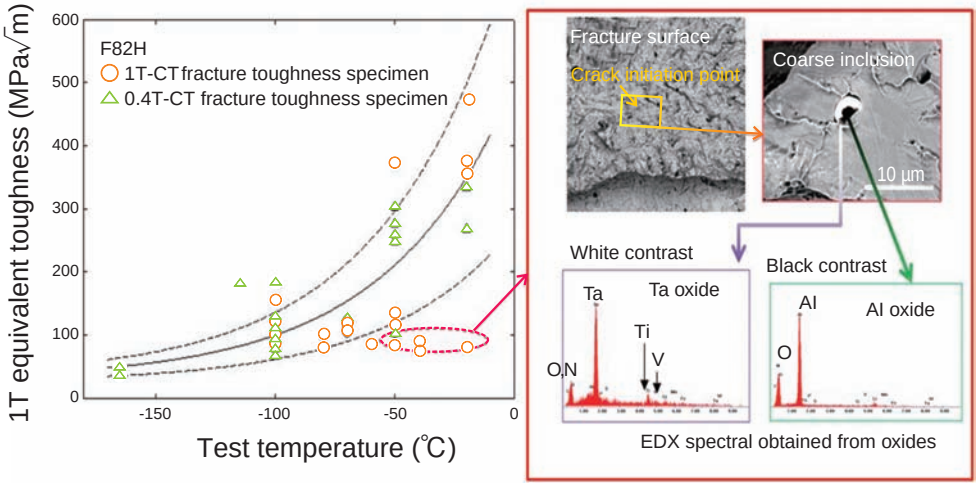

Fig.3-26 The influence of inclusions on the toughness of F82H
A coarse inclusion was found at a crack initiation point on the fractured surface of a specimen that showed low toughness beyond the dispersion latitude in the ductile brittle transition temperature region.

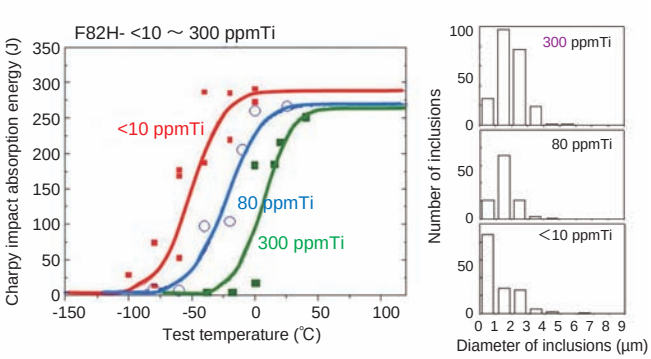

Fig.3-27 The impact of Ti contamination level in F82H
F82H with controlled Ti content was prepared to evaluate the impact of the Ti contamination level, and it was proven that the Charpy impact property was improved (left) and the formation of coarse inclusions was suppressed (right) as the Ti quantity was reduced.

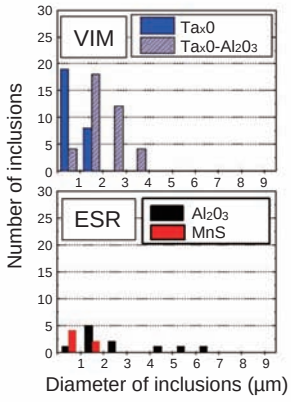

Fig.3-28 Inclusion removal by ESR
ESR was conducted after VIM for further removing inclusions, and no Ta oxide was observed in ESRed F82H except for low numbers of Al_2O_3 and MnS.

Reduced activation ferritic/martensitic (RAFM) steels are recognized as the primary candidate structural materials for fusion blanket systems, based on massive industrial experience with high chromium heat resistant steels and its high resistance to irradiation effects. F82H (Fe-8Cr-2W-0.2V-0.04Ta-0.1C) was designed with an emphasis on high temperature properties and weldability, and now F82H has the most extensive database among RAFM steels.

Ta, which is not used as an additive in conventional steels, is used to provide toughness and creep strength. A recent study revealed that Ta had formed coarse inclusions, which are a compound oxide of Al oxide and Ta oxide with Ti and N, and which have an undesirable influence on the toughness and fatigue properties (Fig.3-26).

Based on the fact that the coarse inclusions contained Ti, the impact of the Ti contamination level in F82H was examined, and improvement of the Charpy impact property and reduction of coarse inclusion formation were proven (Fig.3-27). Electroslag remelting (ESR) was also implemented as a secondary refinement after vacuum induction melting (VIM), and it was proven that ESR could remove Ta rich inclusions (Fig.3-28).

Reference

Tanigawa, H. et al., Effect of Ta Rich Inclusions and Microstructure Change During Precracking on Bimodal Fracture of Reduced-Activation Ferritic/Martensitic Steels Observed in Transition Range, Journal of ASTM International (JAI), vol.6, issue 5, 2009, JAI101728 (10p.).