Dissolution behavior of stainless steel into Fe-Cr-Ni-B-C alloy

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Abstract: To assess the access route to the fuel debris in nuclear power plant, corrosion condition of the structural stainless steel by the corium should be clarified. By immersion experiment, the dissolution behavior of boron and carbon into the stainless steel was estimated. Meanwhile, the influence of grain size on the dissolution behavior was indicated.

Keywords: Severe accident, Fuel debris, Dissolution, Diffusion coefficient, Stainless steel.

1. Introduction

The severe accident that broke out at Fukushima Daiichi Nuclear Power Plant has led to an eventual catastrophic. During the accident, the control rods (B_4C) dissolved into the cladding tube (stainless steel) at high temperature and melt into the corium.[1] It would flow down to the bottom of the plant and react with the supported stainless steel. To treat the fuel debris in reactor, it is necessary to understand the dissolution behavior between the stainless steel and the corium. In this study, the diffusion coefficient of boron and carbon into stainless steel was estimated by immersion experiment. The influence of grain size and immersion time was investigated.

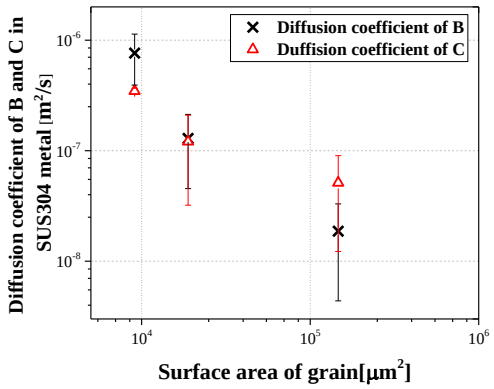

Fig.1 The effect of grain size on diffusion coefficient

2. Experiment

The corium was simulated by the stainless steel and B_4C powder. Protected by the Ar-H_2 gas, they were synthesized at 1723 K in an alumina crucible. After adjusting the temperature at 1573 K in furnace, stainless steel (SUS304) rods, which had various grain sizes, were immersed into the molten alloy for certain minutes. Then, the rod together with the crucible was taken out of the furnace and quenched immediately by water. The rod surrounded by the alloy was cut and the chemical composition around the interface between steel and alloy were analyzed by EPMA.

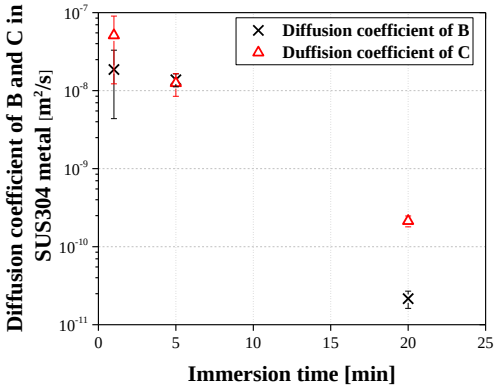

Fig.2 The diffusion coefficient varied with time

3. Results and discussion

The grain size of stainless steel rod was evaluated by the grain surface area measured in the cross section. The diffusion coefficient of B and C in stainless steel were estimated based on the Fick`s second law. The effect of grain size on the diffusion coefficient at 1 min immersion was obtained as shown in **Fig.1**. It was found that the diffusion coefficient of B and C decreased with the increase in the grain size. It might be caused by the decrease of diffusion path between grain particles. Figure 2 showed the diffusion coefficient varied with immersion time at the same grain size of steel rod. Along with time, the concentration difference between molten alloy and steel grain became smaller gradually, and the diffusion coefficient of B and C decreased. In the future, the effect of immersion temperature and addition of Zirconium will be studied.

References

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