

Corrosion Issues of Cu-alloy toward DEMO Divertor

(3) Corrosion behavior of CuCrZr alloy in hydrogen-dissolved high temperature high pressure water environment

*Yen-Jui Huang¹, Motoki Nakajima¹, Naofumi Nakazato², Taisei Nemoto², Yu Seiriki², Takashi Nozawa¹,
Hirotatsu Kishimoto²
¹QST ²Muroran IT

Abstract

The compatibility of Cu-alloy (CuCrZr) with high-temperature high-pressure water, and its corrosion behavior was evaluated. Static corrosion tests in hydrogen-dissolved water were conducted up to 500hr. Weight change of specimens was smaller than those in deaerated water. Specimen surface was sponge-like with crystals on surface.

Keywords: Divertor, Corrosion, Cu-alloy, High temperature pressurized water

1. Introduction

CuCrZr alloy is the major candidate material of cooling pipe of water-cooling divertors in ITER and DEMO fusion reactors [1,2]. To ensure the integrity of water-cooling system, it is necessary not only to understand the compatibility of CuCrZr alloy with high-temperature and high-pressure water but also to evaluate corrosion behavior [3]. On the other hand, as those in-service LWRs, hydrogen injection technique may be applied to mitigate corrosion. Hydrogen isotope permeation from high density plasma to coolants may also increase dissolved hydrogen (DH) content. This study focused on the static corrosion behavior of CuCrZr alloy in high-temperature high-pressure water with DH. After tests, the weight change was measured; specimen surface and depth profile were analyzed by SEM and TEM.

2. Experimentals

The solution-annealing and aged (SAA) heat-treated CuCrZr coupon was prepared and polished up to 0.05 μ m before tests. Tests were conducted in a supercritical water circulation loop with pressure at 15MPa, temperature at 200 and 230°C, respectively. The flow rate was \sim 0.7 L/h so as to replace whole water in autoclave every hour. Testing time was 500 hours. After tests, the weight change was measured; specimen surface was analyzed by SEM.

3. Results and discussion

Fig. 1 shows the weight change of Cu alloy by the static corrosion experiments. The weight loss of specimens in deaerated water condition was around -0.3 mg/cm², showing sponge-like surface morphology. Contrarily, with DH addition, weight loss was quite smaller.

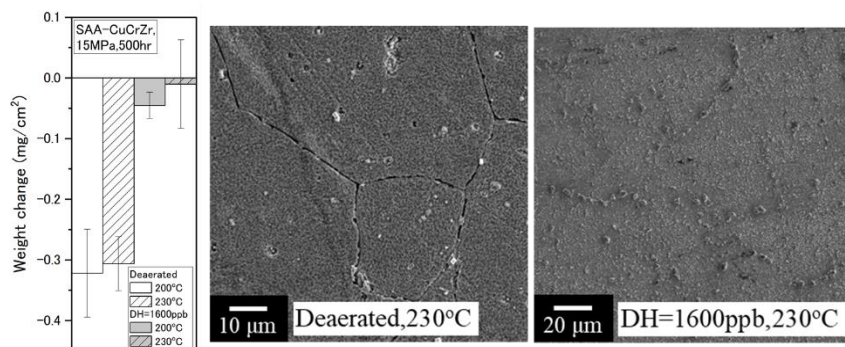


Fig. 1 The weight change and SEM photos of CuCrZr alloy after 500-hour test in high-pressure high-temperature water with deaerated and DH=1600ppb.

The surface morphology of the specimen in hydrogen-dissolved water was also sponge-like but with additional crystals on the surface. STEM-EDX depth profile suggested that crystals were not copper oxides but a recrystallized crystal.

References

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