Research on fundamental technology for SCWR based on RISA (9th report, Effect of metal oxidation on wettability enhancement due to RISA)

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In order to evaluate the effect of metal oxidization on wettability enhancement due to RISA, droplet contact angles on specimens of stainless steel (SUS-304), which were oxidized by immersing in a supercritical water were measured at the high temperatures up to 290 ºC before and after γ-ray irradiation.

Keywords: SCWR, RISA, boiling heat transfer, wettability

1. Introduction

A supercritical water-cooled reactor (SCWR) is one of the 4th generation nuclear reactors, which is simple, compact and high thermal efficiency [1]. Fundamental knowledges on surface wettability and boiling heat transfer on metals at sub-critical conditions under radiation is important in reactor safety analysis of the SCWR. On the other hand, the radiation induced surface activation (RISA) enhances wettability and anticorrosive effect on metal surface [2]. The purpose of this study is to confirm the effect of metal oxidation and γ-ray irradiation on metal surface wettability in high temperature conditions.

2. Experimental

A specimen was installed in a pressure vessel which was pressurized at 12 MPa by nitrogen gas and set at temperatures of 20, 200, 250 and 290 ºC by heaters. A droplet was injected on a specimen surface from the bottom. 4 types of specimen; normal SUS-304, SUS-304 with oxide film, SUS-304 after γ-ray irradiation and SUS-304 with oxide film after γ-ray irradiation were used. The oxide film on specimen was formed in a supercritical water at 380 ºC and 22 MPa for 60 hours. 60-Co γ-ray source was used for irradiation and the integrated irradiation dose was approximately 770 kGy.

3. Conclusion

Fig. 1 shows the typical droplet images on each specimen, which were taken at temperatures of 20 ºC and 290 ºC. Fig. 2 shows the temperature dependence on contact angle changes. The plots with a dot indicate the averaged value of 3 or 4 data which were obtained to check the reproducibility. As shown in the figures, an insignificant effect of oxidization on wettability change was confirmed at a room temperature, while contact angles on the oxidized specimen decreased at high temperatures even before irradiation. On the other hand, the surface wettability on specimens after γ-ray irradiation was improved regardless of specimen type, while the changes in contact angle due to radiation was reduced at high temperatures. This result suggests oxide film formation on metal surface plays an important role in surface wettability enhancement by RISA.

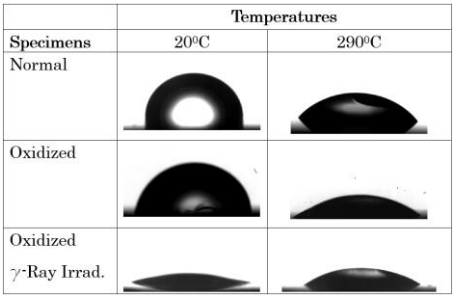

Fig. 1 Typical droplet images

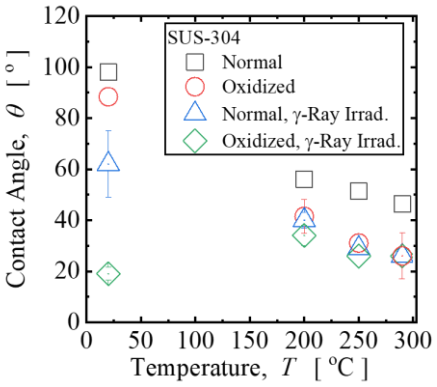

Fig. 2 Droplet contact angles

References

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