High-temperature Oxidation Behavior of 304 Stainless Steel in Argon Gas Containing Cesium Molybdate.

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Abstract. The oxidation behavior of 304 stainless steel (304 SS) in argon gas containing cesium molybdate is examined over the range 270 to 1230°C from 1 to 9 hours. The surface and cross-section of SS304 is analyzed by X-ray diffraction, micro-Raman and electron probe micro analyzer.

Keywords: cesium molybdate, stainless steel, oxidation, severe accident

The oxidation of SUS has been investigated in detail by many investigators. The SUS exhibit good oxidation resistance at high temperature because of the formation of Cr_2O_3 scale protective layer. However, the resistance will be reduced in the steam atmosphere since the Cr_2O_3 layer will be reacted with water vapor, forming a volatile species $CrO_2(OH)_2$. The evaporation of the protective chromium oxide layer caused the exposed iron oxide, which means the oxidation rate will be increased.

After the Three Mile Island and Fukushima Nuclear Daiichi nuclear severe accidents, the reaction between SUS with Cs compounds have been received big attention due to the deposit of fission product on the structure surface, cause the increasing the surface dose rate [1, 2, 3]. It was found that Cs has been diffused into the SUS and probably has reacted with Cr to form Cs_2CrO_4 or $Cs_2Cr_2O_7$ [2]. Besides, cesium may also react with silicon (Si) formed $Cs_2Si_4O_9$ or $Cs_2Si_2O_5$ [3]. These reaction products indicated the loss of the Cr_2O_3 protective layer, lead the oxidation rate increase. However, the oxidation depth change was not to be mentioned.

The present study compares the corrosion rates of stainless steels 304 in argon (Ar) gas and in Ar gas containing Cs_2MoO_4 vapor at different temperatures at various times. The study aims to understand the dry oxidation of SUS304, which is used as a typical material for reactor structures in the Cs_2MoO_4 vapor environment.

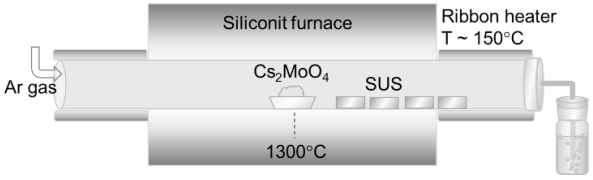

Figure 1 Schematic diagram of experiment setup

SUS304 species with dimensions of 15×10×1 mm were polished by emery paper and buffing before the oxidation. Figure 1 shows the heating furnace used in this experiment. Cs_2MoO_4 was placed at 1300 °C in a platinum (Pt) boat. Ar gas was injected from one side of the tube, flowed passing through the center of the tube where Cs_2MoO_4 vapor was generated at high temperature. On the other side of the tube, SUS304 specimens were placed at different positions to be oxidized at various temperatures from 270 to 1230°C. The oxidation time of interest were 1, 3 and 9 hr. After heating, the surface of the specimens was analyzed by X-ray diffraction and micro-Raman. The elemental distribution was performed by electron probe microanalyzer. The thickness of the oxide layer was estimated by the observation of cross-sections. Figure 2 shows the mass gain and oxidation rate of SUS304 increase with temperature.

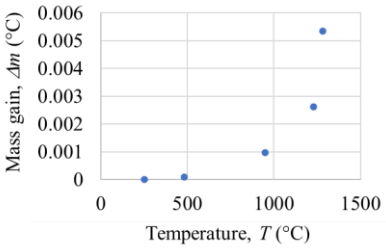

Figure 2 Oxidation curve of SUS304 at various temperature for 1 hour in Ar

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