Cesium molybdate traps by silicon oxide coated stainless steel 304

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Abstract: In the next generation of the nuclear reactors, it is necessary to minimize the amount of cesium (Cs) release to the reactor containment building and outside in case of severe accidents. As traps of Cs vapor, in the form of cesium molybdate (Cs_2MoO_4), silicon oxide (SiO_2) coated stainless steel 304 is proposed to react between Cs_2MoO_4 and SiO_2 at various temperature. Results of high temperature tests are shown in the presentation.

Keywords: Cesium molybdate, stainless steel, reaction, oxidation, severe accident.

The Fukushima Daiichi nuclear power plant accident in March 2011 released an amount of cesium (Cs) into the environment and affected human life. In the next generation nuclear reactors, it is necessary to build a system to minimize the Cs releasing to the containment building and outside.

The Cs-containing vapor, in the form of cesium hydroxide (CsOH) and cesium molybdate (Cs_2MoO_4) on the way released from the fuel to the containment, will pass through to a steam separator and a steam drier. The temperature at this position may go up to 1000 °C during the severe accident, so Cs-containing vapor may deposit or react to the surface. Therefore, the idea of this study is to capture Cs on the surface of the steam separator and the steam drier.

Normally, the steam separator is made of stainless steel (SUS) 304. At high temperature (T ~ 960°C), Cs compounds will deposit on the oxidized layer on SUS304, and the reaction between Cs and chromium (Cr) will take place. This reaction forms cesium chromates which cause the failure of steam separator and steam drier in the steam environment.

This research proposes the stainless-steel coated by silicon (Si) and its oxide for the steam separator. The cesium compounds passing through the steam separator reacts with silicon oxide (SiO_2), the reaction product could be cesium silicates such as $Cs_2Si_4O_9$ which is supposed to be more stable compare to Cs_2CrO_4 in steam environment.

Figure 1 shows the distribution of elements on the surface of SUS coated Si after heating at 700 °C for 20 minutes in argon and steam containing Cs_2MoO_4. It can be seen that Cs_2MoO_4 was deposited on the surface, and a thin layer of Cs-Si-O was detected. However, it is difficult to confirm the reaction of Cs_2MoO_4 with SiO_2, also the form of cesium silicates. The diffusion of Cs compounds is analyzed by observing the cross-section of SUS.

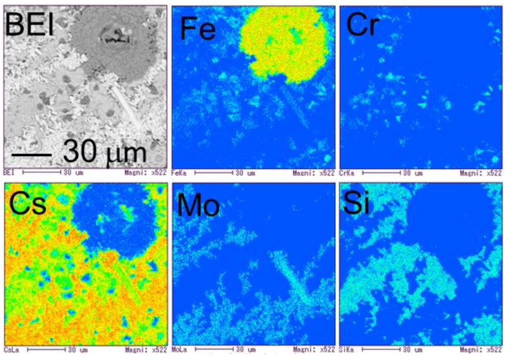

Figure 1. Element mapping image of deposit on the surface.