Deposition of cesium molybdate on concrete at 550 to 950°C in Argon gas

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Abstract:
Deposition of cesium molybdates on concrete in dry condition was studied by transpiration tests. The chemical reactions on the surface of concrete after heating were characterized by X-ray diffraction, micro-Raman spectroscopy and electron probe micro analyzer.

Keywords: cesium molybdate, concrete, cesium silicates, reaction, severe accident

1. Introduction

Fission products (FP) such as cesium, iodine, strontium had been detected in the environment after Fukushima nuclear severe accident. This suggested that these FPs especially cesium could migrate and accumulate in the structural materials inside the nuclear reactor as well as on the concrete wall before releasing to outside. Recently, some studies have been declared the formation of cesium silicate compounds in stainless steel which heated in CsOH vapor [1]. This finding suggests that the cesium silicates also could be formed when cesium compounds deposit/contact on the surface of the concrete where has a large amount of SiO_2 content. In the result of Phebus Test 1, there was 16% of cesium still remained in the core [2], so when the core melted and flowed onto the concrete surface, the reaction between cesium and SiO_2 are possible. Continuing with our previous research that assuming cesium form is mainly Cs_2MoO_4, in this study, the reaction between Cs_2MoO_4 (s) and concrete at 550 - 950°C will be studied.

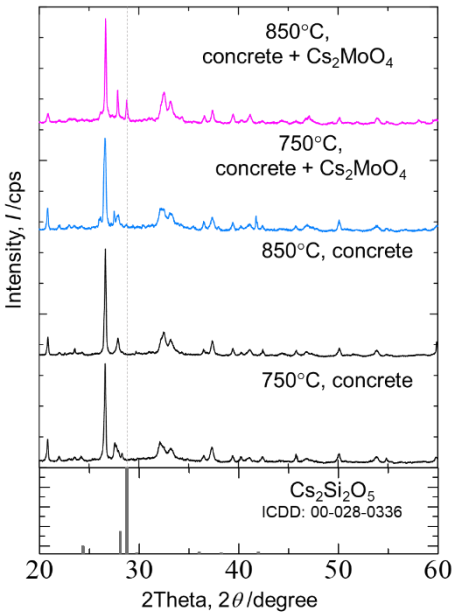
2. Experiment

Cs_2MoO_4 was synthesized in the airflow by the reaction between accurately weighted quantities of cesium carbonate (Cs_2CO_3, 99.9%, Alfa Aesar) and molybdenum oxide (MoO_3, 99.9%, Wako). The powder mixture was heated at 550°C for 2 hours in a platinum boat and then heat treatment at 350°C for 6 hours. The purity of synthesized Cs_2MoO_4 was examined by X-ray diffraction. No secondary phase was detected, the purity of Cs_2MoO_4 is expected to be 99.9 wt%.

Concrete was milled into powder after preheating at 100°C for 500 hours. Then the heating tests were carried out at temperature range 550-950°C for 1 hour. There were two kinds of heating experiments, one was concrete and the other was the mixture of concrete and Cs_2MoO_4 powder with the 4:1 ratio. After heating, the samples were analyzed by XRD, Raman to identify the phase composition.

3. Results

Fig. 1 shows XRD patterns of the sample before and after heated at 750 and 850°C. The phases are identified as mainly SiO_2, CaO, Fe_2O_3. There is no difference in XRD patterns of those samples with and without Cs_2MoO_4 heated at 750°C, but it seems that $Cs_2Si_2O_5$ has formed in those heated at 850°C with Cs_2MoO_4. This result suggests that the reaction between Cs_2MoO_4 (s) with concrete will start at about 850°C or higher.



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