Reaction products in Cs-adsorption on concrete in the 600 – 150°C temperature range

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Abstract: The interaction between Cs_2MoO_4 with concrete within the temperature range of 600 – 150°C in Ar gas is studied. The reaction products included cesium silicate compounds are analyzed by XRD, EPMA and micro-Raman. The obtained results are contributed to the fundamental understanding on the chemical behavior of Cs_2MoO_4 in BWR severe accidents.

Keywords: cesium molybdate, concrete, chemisorption, severe accident.

1. Introduction

When a nuclear severe accident happens, the release of fission products such as Cs, I… is a major issue. Cesium is supposed to be released as Cs_2MoO_4 which is a highly radiotoxic and volatile form. During transport to the outside, Cs_2MoO_4 could deposit on the structure materials such as SUS or concretes. The reaction between Cs_2MoO_4 and SiO_2 which is one of the components in oxide stainless or in concrete become a key issue. The evidence of the reaction between Cs and Si have been declared recently. To have further insight on the role of the chemical species involved in the cesium chemistry, a transpiration system has been developed to analyze the possible phases could be formed. This work is limited to the deposition and the possible interaction between Cs_2MoO_4 in either solid and aerosol phases on the surface of concrete.

2. Experiment procedure

Before the transpiration tests, concrete were heat treated at 100°C for 21 days and then were cut into small pieces with the size about 12 x 8 x 3 mm).

Cs_2MoO_4 was placed in a platinum boat and heated in an alumina tube at 1300°C. Then, two transpiration tests were performed separately. The first one is the test when Cs_2MoO_4 deposit as aerosol particles. Concrete pieces were placed into downstream at different positions that in accordance at 460, 273, 213 and 150°C, respectively. The test was performed for 1 hour in Ar gas environment. After the transpiration test, concrete pieces were analyzed by optical microscopy, X-ray diffraction, micro-Raman spectroscopy and electron probe micro analysis.

3. Results and Discussion

Fig. 1 shows that the XRD patterns of concrete samples at different temperatures after Cs_2MoO_4 aerosol particles deposited on. The main peaks obtained were SiO_2 with the different crystal structure. Comparing with the pattern of the pre-heat concrete sample, the phase compositions have no different, except the intensities of each phase.

From optical microscope images, Cs_2MoO_4 deposited on the concretes were detected. Raman spectra of these areas were assigned mainly of SiO_2 and Fe_3O_4. It seems that there is no reaction between Cs_2MoO_4 aerosol particles with concrete at these temperatures. However, because of the hygroscopic property, Cs_2MoO_4 aerosol particles change to the liquid phase and quickly diffused inside the concrete bulk. Therefore, the phase composition was mainly of the concrete phases.

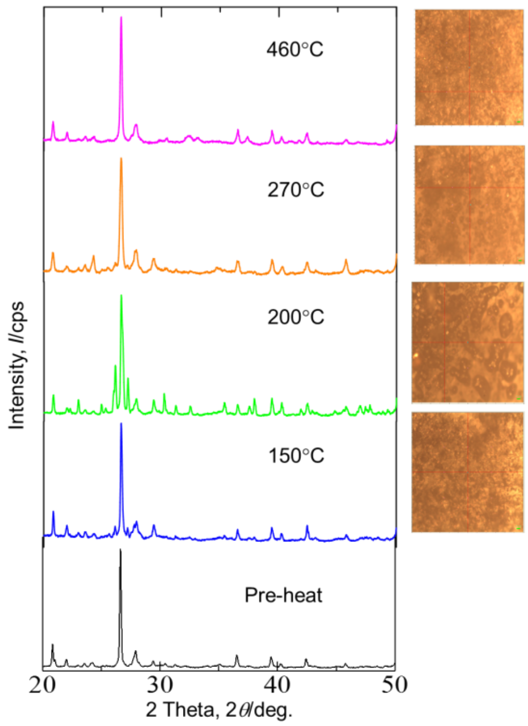

Fig. 1 XRD patterns and optical microscope images of concretes surface at different temperatures.

4. References
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