Study on coating technic to enhance accident tolerance of fuel cladding II
(4) Steam oxidation of Ti-coated SiC as Accident Tolerant Fuel Cladding

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Coating of Ti on SiC was proposed to improve its long-term corrosion resistance in high-temperature water. Steam oxidation kinetics and behavior of Ti-coated SiC are studied via a thermogravimetric system at 1200-1500 ºC. Influence of the Ti coating layer on oxidation kinetics and behavior of SiC will then be discussed and reported in this study.
Keywords: ATF, SiC, coating, high temperatures, steam oxidation,

1. Introduction

Silicon carbide is the most prominent candidate for accident tolerant fuel cladding in terms of oxidation resistance and cladding integrity at high temperature steam [1]. However, dilution of silica from SiC in aqueous environment under long-term operation can become a concern when considering SiC as nuclear-grade materials [2]. To improve the corrosion resistance in water under normal operation, Ti coating on SiC was proposed. In this study, oxidation tests in steam of Ti-coated SiC samples via a thermogravimetric system at 1200-1500 ºC were conducted. To investigate the influence of Ti coating layer on the oxidation of SiC, oxidation tests of CVD-SiC and Zry-4 samples at 1300 ºC were also conducted and discussed.

2. Experimental procedure

Samples (10x10x1 mm) used in this study are prepared from SiC/SiC composites with approximately 100 μm in thickness of SiC overcoat layer obtained by chemical vapor deposition (CVD) method. Final coating of Ti-Cr layers (approximately 15 μm in thickness) were obtained by physical vapor deposition (PVD) method. Details of coating design and method have been reported elsewhere [3]. Since the Ti coating layer is the topcoat (the final coating) layer, the SiC samples with Ti-Cr layers are referred as Ti-coated SiC hereafter. Oxidation tests of Ti-coated SiC samples at 1200-1500 ºC for 2 hours under a stream of 60 vol.% H_2O/Ar gas mixture were conducted via a thermogravimetry (STA 2500 Regulus, NETZSCH). Quantitative measurement of hydrogen gas generated during the oxidation tests was performed by a sensor gas chromatography (SGHA-P2, FIS Inc.).

3. Results

Results of this investigation indicated that oxidation kinetics of Ti-coated SiC at 1200-1500 ºC was observed with two different states. The first state of oxidation seemed to cause by the oxidation Ti coating layers which was faster than the second oxidation state. The oxidation rate observed in the second oxidation state of Ti-coated SiC at 1300 ºC was almost identical to the oxidation rate of CVD-SiC at the same conditions. This observation suggested that Ti coating layer did not negatively influence much on the oxidation resistance of SiC substrate. In comparison with Zry-4, both Ti-coated SiC and CVD-SiC showed favorable aspects on oxidation resistance and hydrogen generation during the oxidation at 1300 ºC for 2 hours. Details of microstructure evolution of samples will be presented in the presentation.

References

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