# Steam Oxidation of Silicon Carbide at High Temperature up to 1800ºC

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Abstract

Silicon carbide has been considered as a potential candidate for fuel cladding. Many studies have been conducted to investigate the steam oxidation of SiC at temperatures below 1600ºC. However, the steam oxidation behavior of SiC at temperatures above 1600ºC remained unclear due to the lack of test facilities. In this study, we investigated the steam oxidation of SiC at temperatures ranging from 1400-1800ºC using a newly developed laser heating facility.

**Keywords:** Steam oxidation, SiC, accident tolerant fuel, LAHF-facility

## 1. Introduction

Silicon carbide (SiC) has recently attracted much attention as a potential material for accident tolerant fuel cladding. Since the accident occurred in Fukushima-Daiichi nuclear power station which could cause the temperature of fuel rods raising up to 2000ºC, there is a high demand to seek a potential candidate for future fuel cladding. Many studies have indicated that oxidation rate of SiC in steam is much lower than that of Zircaloy and therefore induces lower hydrogen generation rate. Nevertheless, most of the studies were conducted at the temperatures below 1600ºC due to the lack of test facilities which can perform oxidation tests at higher temperatures in steam. In this study, we developed a laser heating test facility (LAHF) and investigated the steam oxidation of SiC at temperatures ranging from 1400-1800ºC.

## 2. Experimental details

Monolithic SiC sample (10x10x1 mm) was set into the test chamber as shown in Fig. 1. Steam, Ar carrier gas, gas pipes, chamber and view ports were heated up to 150ºC. Temperature of sample during the test was measured by two pyrometers. Flow rate of steam was set to 3 g/min which induced the steam partial pressure of 0.97 atm in the chamber. The investigation was conducted at 1400-1800ºC for 1-7h with a heating rate of 0.5ºC/s. During the test, sample appearance was monitored by a video camera. Amount of hydrogen and carbon monoxide generated during the test was measured by a gas chromatography. After the tests, sample characterization was performed with SEM and XRD.

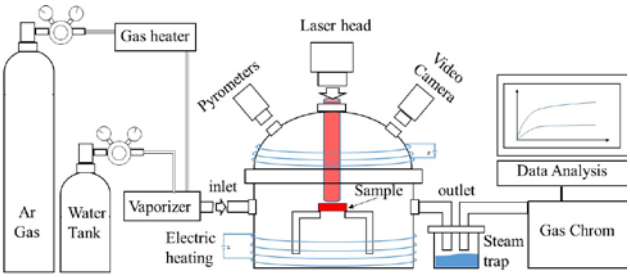


Fig. 1. Schematic diagram of the laser heating facility

## 3. Results

SiC samples experienced a mass loss under the investigated conditions. A dense oxide layer was observed on sample surface. Results of the study showed that the steam oxidation of SiC under these conditions followed paralinear law. This fact indicated that the oxidation parabolic rate and linear volatilization rate reached to steady state. In addition, bubbling phenomenon was observed on the surface at 1800ºC. This suggests that a different mechanism of the steam oxidation of SiC at higher temperatures.

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