7P65 微小試験法によるセラミックス被覆の界面せん断応力評価

Evaluation of shear strength on ceramic coatings by small specimen testing method

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1. Introduction

Silicon carbide (SiC) have gained attention as one of the candidate materials for blankets in fusion reactor due to its excellent properties at high temperature even after neutron irradiation. However, it was reported that the corrosion of SiC by various coolants was accelerated by irradiation. To improve the corrosion resistance, the coated layer is essential. Although Al_2O_3 is frequently used for protective coatings of metals, coating Al_2O_3 on SiC is extremely difficult due to the absence of techniques for joining dense and thin Al_2O_3 with SiC. In this study, the Al_2O_3 was coated on SiC with bonding layer (mullite) by using the laser-assisted CVD method. The micro-double notches shear (DNS) testing was employed for evaluating the shear strength of coating systems, and the irradiation effects on the strength and microstructure were also tested.

2. Experimental

The DNS samples with typically 5×5×10 μm in pillar shape were made at each interface by Focused Ion Beam (FIB). For comparison between the interfacial shear strength and internal shear strength of coated materials themselves, DNS samples were also made from each separate layer. Then, two notches were provided on the pillar side such that both notches were ended at the interface (see Fig.1) to introduce maximum stress at the interface. The samples were compressed using Nano-indenter equipped with a flat punch tip. The test number for irradiated and unirradiated samples was 15 to calculate the Weibull modulus, respectively.

The coatings were irradiated by DuET at Kyoto university with 5.1 MeV Si^{2+}-ion. The irradiation temperature was 300 °C while the irradiation damage was 10 dpa-SiC at 1250 nm in depth. The microstructural change was studied by transmission electron microscopy (TEM).

3. Results

The interfacial shear strength decreased ~65% after irradiation as shown in Fig. 2. Similar to this, the Weibull modulus (m value) decreased ~81%, meaning larger data scattering for irradiated samples. One of the reasons for the reduction of strength and m values will be discussed in the presentation based on the irradiation induced microstructural change.

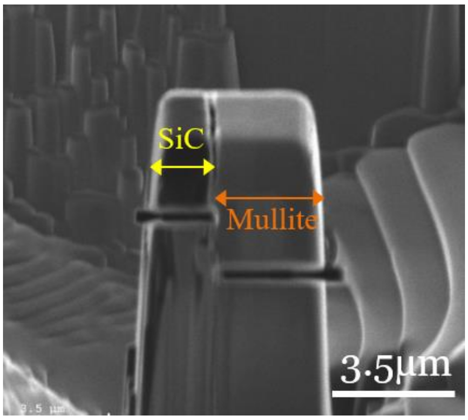

Fig.1 Typical image of DNS sample.

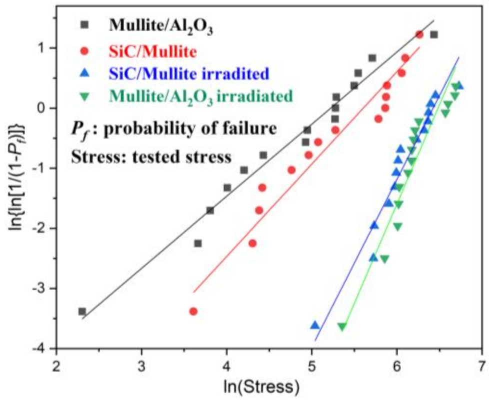

Fig.2 Weibull plots of irradiated and unirradiated samples.

	m value	Characteristic strength (σ_θ)
Mullite/Al_2O_3	6.4	620 MPa
SiC/Mullite	6.5	652 MPa
SiC/Mullite irradiated	1.5	270 MPa
Mullite/Al_2O_3 irradiated	1.2	186 MPa

Table.1 The m value and characteristic strength of irradiated and unirradiated samples.