EVALUATION METHOD OF FRACTURE PROPERTIES OF FIBER-REINFORCED SELF-HEALING CERAMICS

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ABSTRACT

Fiber-reinforced self-healing ceramic (shFRC) [1] is considered to be most attractive candidate of next generation structural materials using at high temperature, e.g. turbine blade, exhaust component of car engine etc. The shFRCs consist of three components, which are oxide fiber bundle, oxide matrix and self-healing agent interlayer. As the self-healing is generated at only the interlayer, it is necessary that crack propagation is led into the interlayer. As a result, shFRCs exhibit complex fracture behavior.

In order to assess the structural integrity of shFRC, the correct fracture toughness including with the complex fracture manner is needed. Dlouhy et al. [2] indicated that the chevron notched specimen technique can be a reliable method to assess fracture behavior in brittle matrix composites reinforced by continuous fibers.

The present study aims to demonstrate the self-healing effect by using the fracture toughness. For the first step of the study, the fracture behavior of shFRC was investigated by using the beam with Chevron notch, where the used Chevron notch has the geometry shown in Fig. 1 [3]. The fracture toughness can be expressed as:

$$K_{IC} = \frac{F_{max}}{\mathrm{B}\sqrt{\mathrm{W}}} Y_C(\alpha_0, \alpha_1) \tag{1}$$

Where K is the fracture toughness, W the height, B the width, F the maximum load of the testing, and Y is the corresponding minimum value of geometrical compliance function, which is evaluated utilizing the reference [3].

Figure 2 shows the load displacement curves of the three point bending beam with the notch of shFRCs as notched (dashed line) and after healing at 1200 ^{o}C for 10 h (solid line), with the optical images of (a) cross-section and (b) surface of the fractured shFRC after healing. From the knowledge of reference [3], it is found that both

as-notched specimen and healed specimen can be deformed with stable crack propagation after displacement become more than the black arrows. Thus, the loads indicated at black arrows were determined to be the load at which the stable crack propagation started, F_{MAX}. Using the value of F_{MAX} and equation (1), the fracture toughness of as-notched shFRC and the healed shFRC were evaluated to be 4.13 $MPAm^{1/2}$ and 4.44 $MPam^{1/2}$, respectively. Although the healed specimen included the healed crack which propagated during the loading as shown in the dashed line and then was healed at 1200 oC for 10 h, the healed shFRC was found to have the higher fracture toughness than as-notched shFRC. Therefore, it is confirmed that the self-healing in shFRC leads to recover the fracture toughness due to complete healing of the crack.

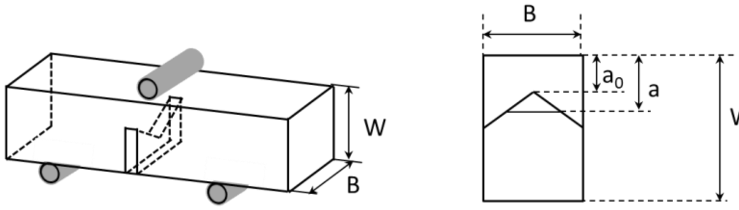

Figure 1 ：Chevron-notched three-point bend bar for toughness test.

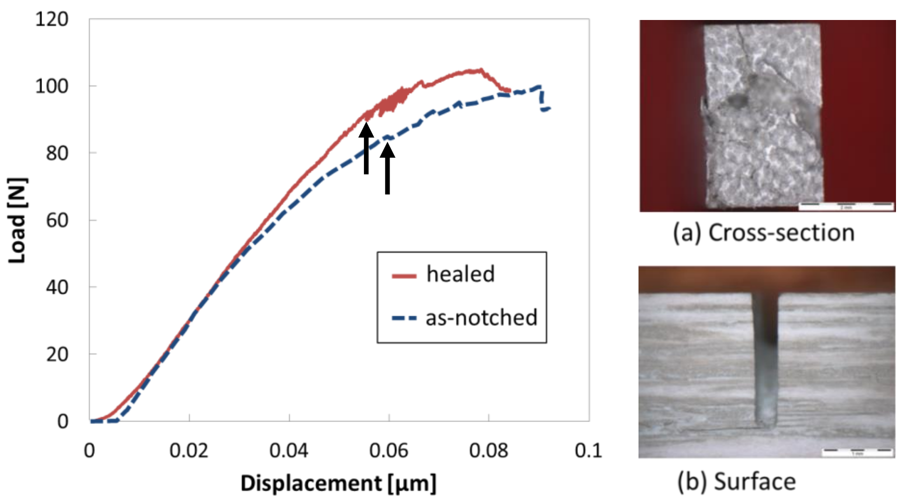

Figure 2：Load displacement curve and optical micrograph

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