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Research on in situ observation of fracture process of fiber/epoxy composites

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Summary

Recent studies have indicated that mechanical performance of the short fiber-reinforced polymers composites not only depends on matrix type, fiber type, fiber weight fraction, fiber orientation, fiber dispersion etc. but fiber-matrix interface and matrix morphology are also of paramount importance. Many scholars have studied on effects of matrix and interface modification on the mechanical behavior of short carbon fiber reinforced epoxy composite. However, there is little work focused on the in situ observation of fracture process of fiber/epoxy composites. And it is difficult to know about crack and crack propagation in the sample without direct observations of fiber-matrix interface when the samples are applied extraneous force. Synchrotron radiation computerized topography (SR-CT) is an advanced technique which allows for direct three-dimensional observations of damage in samples. So it is logical to apply SR-CT to the experimental observation of fiber-matrix interface in samples.

In this paper, Mechanical properties of composites were tested firstly. In order to acquire high quality rebuilding images of fiber-matrix interface of the samples, imaging modes of Synchrotron radiation X-ray were discussed. And then, a special small tensile testing device which can be used to apply extraneous force to small samples when the samples were observed with synchrotron radiation X-ray was designed for the next work. At last, static 3D images of fiber/epoxy composites were got. The content of this paper includes:

1. Two types of standard samples(ISO 527-5:1997, IDT)were prepared for the test of mechanical properties. One consists of non-treated short carbon fibers and epoxy resin(E51). And the other one consists of oxygen treated short carbon fibers and epoxy resin(E51). All the samples contain the same weight fraction(10i?.)of short carbon fiber.

2. Utilize SR-CT, the sharpest static 3D images of fiber/epoxy composites were got, compared to the previous work. As the Absorption of X-ray by carbon fiber is close to that of epoxy resin, phase-contrast imaging technique was used in this experiment.

3. A special small tensile testing device which is matched to the experimental system of NanoCT on beam line 4W1A at the Beijing synchrotron radiation facility (BSRF) was designed. It will be revolved with sample by the rotation axis of rotation device in the experimental system of NanoCT. So the Synchrotron radiation

X-ray will be obstructed by the support bars of tensile testing device on a few angles. How to reconstruct a distinct Three-Dimensional image with limited angle is a challenging work.

The next work is to get three-dimensional images of carbon fiber/epoxy composites when the samples were applied different extraneous forces.