Announcing the Final Examination of Zichao Xia for the degree of Master of Science

Time & Location: March 25, 2011 at 3:00 PM in OTC 304
Title: Effect of Neutron Radiation on the Mechanical Properties of B4C

B4C is an important engineering ceramic used in a number of different applications. One of the promising applications of B4C is in the nuclear industry. B4C has a high neutron absorption cross-section (600 barns) and that is why it can absorb neutrons without forming long lived radio nuclides. As a result, B4C is extensively used as control rods, shielding material and as neutron detectors in nuclear reactors.

During the reactor's operation, the B4C undergoes severe neutron radiation and defects, such as vacancies and helium bubbles, are generated in the structure. These defects are responsible for the degradation of mechanical performance of B4C and can make this material unsuitable for further exploitation. Therefore, both crystal structure and mechanical properties of B4C were studied before and after radiation, as well as for the case when irradiated by neutrons B4C samples has been annealed in order to heal the defects introduced by the radiation. Fully dense B4C ceramics were produced by hot pressing at 2100°C, 30MPa, and 45 minutes dwell time. 120 small bars of 2×2.5×25mm were machined according to the MOR bar standard. 40 bars after machining were tested as they were, 80 bars were irradiated with neutrons in neutron source for 3.5 months. 40 out of the 80 irradiated bars were annealed at 400°C for 1 hour with an attempt to heal the defects possibly introduced by the irradiation.

4-point bending strength, SEVNB fracture toughness, hardness and indentation fracture resistance have been measured on as received B4C, B4C after radiation, and B4C after radiation and annealing. The Weibull parameters were determined for each set of the conditions. The fracture surfaces of the B4C before and after radiation as well as after radiation and annealing have also been analyzed using SEM. X-ray diffractometer was used to collect diffraction pattern of the B4C, and Raman spectrometer was used to evaluate the vibrational response of B4C. Thus the effect of neutron radiation and annealing on mechanical performance and structure of B4C has been analyzed. Funding support for this work from NSF (CAREER DMR-0748364) is acknowledged.

Major: MSE

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Bachelor’s of Physics, BS, 2009, Wuhan University
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Approved for distribution by Dr. Nina Orlovskaya, Committee Chair, on March 25, 2011.

The public is welcome to attend.