STATUS OF SILICON CARBIDE COMPOSITES FOR FUSION -- L. L. Snead (Oak Ridge National Laboratory), R. H. Jones (Pacific Northwest Laboratory), A. Kohyama (Kyoto University), and P. Fenici (JRC-Ispra)

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Extended Abstract

Silicon carbide composites are currently being investigated as potential fusion energy structural materials in the United States, the European Community, and Japan. This paper, which was presented as an invited oral at the ICFRM-7 conference, gives an overview of some of the recent issues regarding the use of this low activation material, including the radiation performance of present day materials and the direction towards the development of radiation hardened SiC composites. Specific topics that were explored in some detail include:

1. SiC as a Low Activation Material

   The question of the true activity of a commercially available SiC-based composite which is used in the first wall and blanket region of a fusion power system is discussed. The effect of the metallic impurity level present in the composite is discussed along with the production of Al-26. It is shown that impurity levels are quite variable and can most likely be controlled. The production of Al-26 is shown to be highly dependent on the position in the machine due to the high energy cross-section thresholds involved. Calculations[1] show that for SiC used away from the first wall, the Al-26, and the associated activity is of no consequence.

2. Helium and Hydrogen Production

   The production of helium and hydrogen are also a function of the incident neutron energy. The helium production ratio is shown to be approximately 130 atoms/dpa at the first wall falling to about 30 atoms/dpa in a typical end of blanket region. This can be compared to a fairly uniform helium production in Type 316 stainless steel of ~20 appm.

3. Dimensional Stability and Amorphization

   The regimes of dimensional stability are discussed and recent work on the temperature threshold for amorphization of SiC reviewed. It is shown that the amorphization threshold is dependent not only on the irradiation temperature but also on the irradiating ion species. The absence of amorphization in neutron irradiated SiC may be due to a spectrum induced threshold temperature shift.

4. Thermal Conductivity

   The thermal conductivity for both chemically vapor deposited SiC and SiC composites are presented. It is seen that the thermal conductivity quickly degrades to some fraction of its initial value, and that this fraction is largely dependent on the irradiation temperature. It is speculated that large improvement from the relatively low thermal conductivity of current day materials can be made and that, for the expected use temperatures of these materials, a saturation reduction in thermal conductivity on the order of 50% can be expected.

5. Irradiation Stability of Present-Day Composites

   Available data on the radiation resistance of Ceramic Grade Nicalon fiber composites are reviewed; the degradation mechanism of the composite is attributed to densification of the Nicalon fiber. Radiation data on improved fibers are presented and discussed and a general direction for the future research is discussed.

[1]H. L. Heinisch, "Activation of Silicon Carbide in Fusion Energy Systems," to be published in Fusion Reactor Materials Semiannual Report. DOE/ER-0313/19 (1995).