

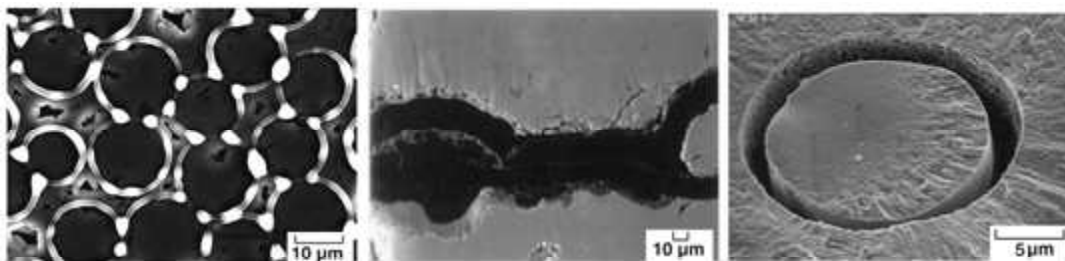
Oxidation of Boron Nitride in Composites

Boron nitride (BN) is a prime candidate for fiber coatings in silicon carbide (SiC) fiber-reinforced SiC matrix composites. The properties of BN allow the fiber to impart beneficial composite properties to the matrix, even at elevated temperatures.

The problem with BN is that it is readily attacked by oxygen. Although BN is an internal component of the composite, a matrix crack or pore can create a path for hot oxygen to attack the BN. This type of attack is not well understood. A variety of phenomena have been observed. These include borosilicate glass formation, volatilization of the BN, and under some conditions, preservation of the BN. In this study at the NASA Lewis Research Center, a series of BN materials and BN-containing model composites were methodically examined to understand the various issues dealing with the oxidation of BN in composites.

Initial studies were done with a series of monolithic BN materials prepared by hot pressing and chemical vapor deposition (CVD). From these studies, we found that BN showed a strong orientation effect in oxidation and was extremely sensitive to the presence of water vapor in the environment. In addition, CVD material deposited at a high temperature showed much better oxidation behavior than CVD material deposited at a lower temperature.

With this information we were able to examine BN oxidation in a composite. Borosilicate glass formation, the most common behavior, occurred when the BN coatings were exposed to oxygen at intermediate temperatures. In these cases, the BN oxidizes to boric oxide (B_2O_3), which enhances SiC oxidation to silica (SiO_2). The two oxidation products react to form borosilicate. It was also observed that as the reaction progressed the B_2O_3 was leached out of the glass by residual water vapor.



Oxidation behavior of model composites with BN layers. Top: At 816 °C for 100 hr with low water vapor, BN deposited at a low temperature forms borosilicate. Middle: At 900 °C for 140 hr with low water vapor, BN deposited at a high temperature remains intact.

Bottom: At 500 °C for 100 hr with water vapor, BN deposited at a low temperature is volatilized.

Another observation was the volatilization of the BN fiber coatings. This was observed in water-vapor-containing environments. Volatilization is caused by oxidation of BN to B_2O_3 and the subsequent reaction with water to form highly stable species of the form $H_xB_yO_z(g)$. We have developed some models to describe this process and predict recession, based on simple diffusion through pores.

Finally, in some cases the BN remained intact. This occurred primarily in model composites with the CVD BN deposited at very high temperatures. Currently, it is not feasible to make commercial materials with this type of BN. In such cases, BN is preserved because of the high stability of these BN materials as well as the gettering of oxygen by SiC, which effectively lowers the oxygen potential below that which B_2O_3 forms.

The data from this series of experiments is being used to understand the issues necessary to improve the properties of BN-such as processing and additives. Current work is focusing on the effectiveness of additives in improving BN oxidation properties.

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