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Processing Reaction Bonded Silicon Carbide – Preliminary Results

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Abstract – This study focused on the evaluation of the kind of petroleum coke on processing of the reaction bonded silicon carbide ceramics (RBSiC). The results obtained showed that the coke must have the least possible amount of gases in order to produce a homogenously infiltrated material.

Reaction bonded silicon carbide (RBSiC) is an important advanced ceramic. It has processing and properties that are very promising; for instance, it is processed in near-net shape, requires lower temperature than conventional sintering, good mechanical and tribological properties. The RBSiC is obtained by the infiltration of metallic silicon melt into a porous green body formed by silicon carbide (SiC) and carbon. During the infiltration, the silicon melt must reacts with the carbon to exothermically form a new SiC [1,2].

To obtain a high quality material is not an easy task, since successful infiltration must occur throughout the microporous green body. During the complex infiltration reaction, the SiC formation is highly volume expansive with respect to the carbon phase; on the other hand, there exists a net volume reduction when the Si melt reacts with the solid carbon to originate SiC. Problems related with the process are incomplete infiltration due to reaction chocking, flaws resulted from thermal stresses and volume expansion stresses [1].

This study focused on the evaluation of the type of petroleum coke used to process RBSiC, since it must be an important player to obtain high quality material. Three types of cokes were used, namely: green coke, calcinated coke (without binder), and calcinated coke with binder. Each one was mixture with SiC powder, ball milled for 12 hours, dried, desaglomerated and, then, uniaxially pressed. The next step was to sinter at 1550 ºC in vacuum.

The green coke mixture resulted in partial infiltration, promoted chocking and cracks, as demonstrated in Figures 1A and 1B. These problems were majorly attributed to the high amount of gases contained in the green coke used. To confirm this hypothesis, each type of coke was individually calcinated in the furnace, as shown in Figure 1C. It is observed that the green coke has an enormous amount of gases which started to be released at 400 C, while the calcinated cokes started above 1000 ℃.

It is proposed the following mechanism for the defects observed in mixture processed with the green coke: during the process at low temperatures (400 to 800 ºC), the released gases increased the internal pressure in material which does not have enough strength and, consequently, cracks were generated. As the temperature goes above 1410 ºC, the silicon melt tried to infiltrate, but there still enough gases to prevent it to get into the material. The partial infiltration can have occured through the cracks formed at lower temperatures and it does not happen homogeneous in volume.

The results obtained so far indicate that the coke must have the least possible amount of gases in order to produce a homogenously infiltrated material.

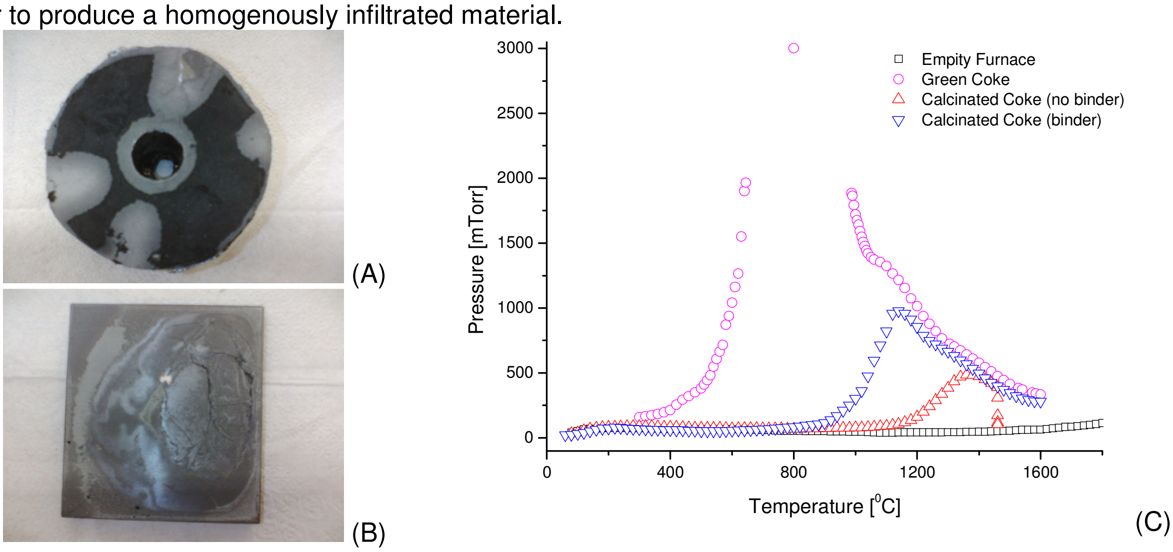

Figure 1 – Effects of gases in the green coke used to process RBSiC. (A) partial infiltration and chocking, (B) surface cracks. (C) Amount of gases in the three types of coke used.

1- Materials Science and Engineering, A144 (1991) 63-74
2- Carbon, V. 42 (2004) 1833-1839