11th International Conference on Advanced Materials
Rio de Janeiro Brazil
September 20 - 25
ICAM2009

Evaluation of Flexure Strength of SiC Degraded in Acid and Base Media

M. G. S. Pereira(1)* and C. A. Costa(1)

(1) PEMM/COPPE/UFRJ – P.O. Box 68505, Zip Code 21941-972, Rio de Janeiro, RJ –, e-mail: mgpereira@metalmat.ufrj.br - * Corresponding author.

Abstract – Silicon carbides were sinterized by solid state (SS) and liquid phase (LP) methods. Weight variation and flexure strength were characterized before and after chemical attacks. Samples were degraded using 98% H_2SO_4 and 50% NaOH for 30, 150 and 300 hours. It was observed no weigh gain on SiC-SS and a weight gain of 4,2% on the SiC-LP. A decrease in flexure stress of 48% for acid and 63% for base was observed, but for SiC-SS only a marginal reduction - the tendency was observed for modulus. All degradations in SiC-LP occurred up to 30 hours of test, while none was noticed for 300 hours of test for SiC-SS.

Silicon carbide (SiC) is a structural ceramic and has been quite used in seats of mechanical seals due its low coefficient of friction, high resistance to thermal shock and capable to maintain properties at very high temperature. The SiC can be sintered by solid state (SS), presence of liquid phase (LP) or reaction bonded (RBSiC).

The API 682 standard recommends the application of SS and RBSiC for the petroleum industry, but not the LP material. The API selection is based on the mechanical properties for each type of SiC, which depends on many parameters, such as, particle size distribution, sintering conditions, density, pore structure, intergranular phases presents, etc. [1-3].

This study purposes to compare the effects of a strong acid and a strong base on the mechanical behavior of two types of SiC, one processed by solid state (SS) and the other by liquid phase sintering (LP). It is worth mention that there is few publications about this subject in literature.

The SiC-SS was sintered with a high purity powder (> 99% pure) and the SiC-LP used 97,8% pure powder. The Arquimedes density for the SS and LP were 98% and 84%, respectively. Both SiCs were degraded using 98% H_2SO_4 and 50% NaOH. They were kept immersed on these media for 30, 150 and 300 hours. Mechanical properties were measured by four-point flexure and surface microstructure by SEM. The materials were characterized before and after degradation.

The four-point flexure curve of SiC-SS showed a marginal reduction in strength and none in modulus for both H_2SO_4 and NaOH, attesting an inert material for these media. On the other hand, the SiC-LP had a reduction of more than 35% in strength and modulus, as can be seen in Table 1. It was also observed that SiC-SS had no weight variation in any media, while SiC-LP presented a weight gain of 4,2% in both H_2SO_4 and NaOH, for all degradation times. The mass increase in SiC-LP can be explained by deposition of acid and base products on a high porosity material. In SiC-LP samples degraded in H_2SO_4, it was observed particles with ribbon shapes (figure 1-a) and in NaOH needle shapes (figure 1-b). The EDS performed on SS degraded material showed the presence of Si-C-S or Si-C-Na, and on the LP the elements Si-C-Al-S or Si-C-Al-Na, depending on the media used. The yttrium element was not detected. The reduction of the mechanical strength of SiC-LP possibly occurred by chemical attack of the acid and base to the intergranular phase that does exists on this kind of material. The chemical attack is effective in only 30 hours or less, since all weight gain and strength reduction do not change after 30 hours.

Table 1: Mechanical properties of SiC after degradation in acid and base media.

Material	Flexure Stress	Elastic Module
LP-SiC- H_2SO_4	- 48%	- 37%
LP-SiC-NaOH	- 63%	- 44%
SS-SiC- H_2SO_4	- 14%	none
SS-SiC-NaOH	- 8%	none

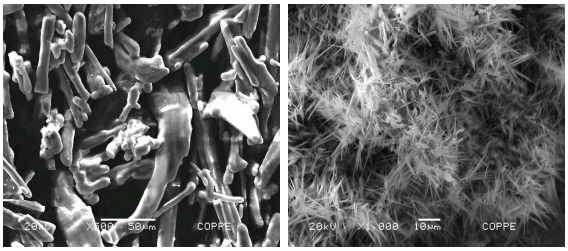

Figure 1: a) Ribbon shape particles observed in samples degraded in H_2SO_4 (LP-SiC-150h-500x), b) Needle shape particles observed in samples degraded in NaOH (SS-SiC-30h-1000x).

References

[1] Carbon V.42; 2004; pp. 1833-1839.
[2] Engineered Materials Handbook, Vol.4, Ceramics and Glasses, ASM International; 1991; p.255-259.