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Composite ceramics based on silicon carbide with layered location of reinforcing SiC fibers

K A Kim [1,2], A S Lysenkov [2], D D Titov [2], Yu F Kargin [2], M G Frolova [2], A V Leonov [2], S N Perevislov [3], E I Istomina [4] and D O Lemeshev [1]

[1]Mendeleev University of Chemical Technology of Russia, Moscow, Russia
[2]Baikov Institute of Metallurgy and Materials Science, Russian Academy of Sciences, Moscow, Russia
[3]Institute of Silicate Chemistry of Russian Academy of Sciences, Saint Petersburg, Russia
[4]Komi Institute of Chemistry, Syktyvkar, Russia

E-mail: Const552@gmail.com

Abstract. The ceramic composites based on SiC with layered location of SiC fibers were obtained and studied. The samples were obtained by hot pressing. In this study the effect of layer quantity on mechanical strength was revealed.

1. Introduction

Silicon carbide is one of the few materials that includes high mechanical properties, stable in aggressive environments and extremely temperatures as well. The main disadvantage of silicon carbide, along with its positive properties, is very fragile, like any ceramic material, this fact is the main reason of properties improvement for example crack resistance and mechanical durability could by improved by reinforcing. As reinforcing material is used SiC nanotubes, SiC whiskers and SiC fibers (SiC_f). It will allow spread a scope of using ceramics.

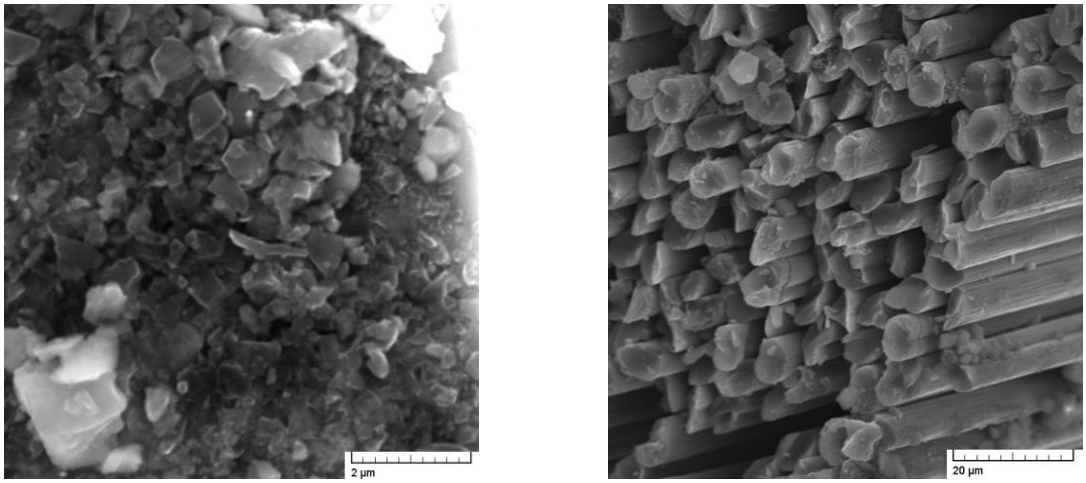
Special attention is paid to the introduction reinforcing particles in ceramic matrix. High surface energy of particles provides compatibility with ceramic matrix, metals and polymers as well. Fibers durability is high despite small diameter 0.01 – 2 μm and up to 1600 °C can be used [1].

Using of highly effective SiC_f is promising direction in the high durable materials development. The main method of SiC_f obtaining based on SiC sedimentation on carbon fibers at a temperature 1300 °C. In this case SiC receives due to heat treatment of alkylsilane.

Authors of many scientific works, for example [2 – 4], homogenize composition of mixtures as much as possible to get uniform spreading of fibers in the matrix, however there are few study works about components organizing. In the scientific research [5] was determined that diameter increasing leads to composite durability decreasing. Optimal amount of SiC_f is up to 8 wt.% [6], if fibers concentration is more than 8 wt.%, then randomness of distribution is increased and it leads to packaging failure. In this study we considered a potential of obtaining and studying properties of composite ceramics with layered location of reinforcing SiC fibers.

2. Materials and Method

As initial raw materials we used SiC powder manufactured by «Saint-Gobain» (Figure 1a) and SiC fibers by Komi Institute of Chemistry production (Figure 1b). SiC powder included 9 wt.% sintering agent Y_2O_3-Al_2O_3 (YAG). The particles size was 0.5 – 1 μm.



(a) (b)

Figure 1. SEM microstructure of (a) – SiC granule, (b) – SiC_f

3. Results and discussion

To obtaining layered ceramics we were guided by simplicity of technology. The main aim was to get ceramics of SiC-SiC_f 3, 5-layer sets. The total weigh of SiC powder was 7 g and weigh of SiC_f was depended on number of layers (≈7 wt.% in the sample). Low mass of SiC_f in the layer due to low bulk density. Obtained properties are shown in the table 1.

Table 1. Properties of ceramic samples

SiC	**SiC_f quantity, mass. %**	**Temperature, °C**	**Density, g/cm^3**	**Porosity, %**	**Durability, MPa**
Granilar SiC «Saint-Gobain»	7 (3 layers)	1850	3,20	0,95	363
Granular SiC «Saint-Gobain»	7 (5 layers)	1850	3,16	0,22	422

Receiving sequence of layered ceramics is simple but it takes high accuracy. The press form was filled in series with the layer of SiC and after with the layer of SiC_f (Figure 2). To spread reinforcing particles of the layer we used a double sided sticky tape. To obtain composite samples we used hot press Thermal Technology Inc. (HP20-3560-20) that allowed to get quite dense ceramic composite without open porosity.

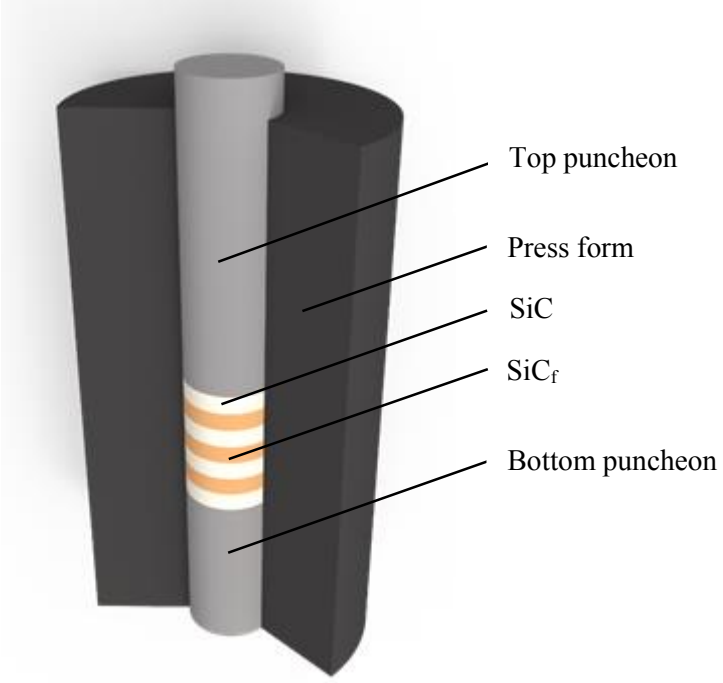
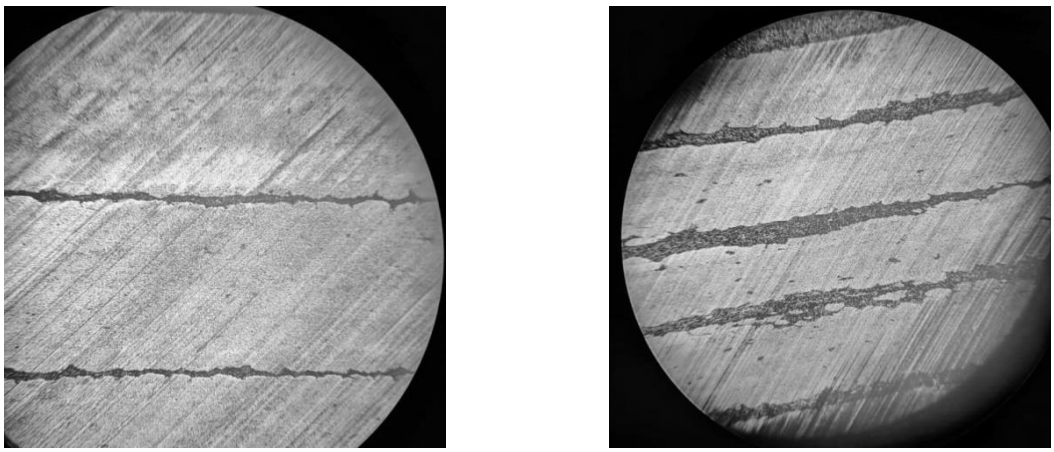


Figure 2. Schematic picture of the samples manufacture



(a) (b)

Figure 3. SiC-composite structure with layered SiC_f (a – 3 sets, b – 5 sets)

4. Conclusions

A study was conducted to determine ceramic composites mechanical properties and results allow us to make conclusions:

- Mechanical properties depend on the number of SiC_f directly. Depending on this fact it is possible to vary final properties of the composite;
- Depending on the fibers length could be a difference between mechanical strength and resilience. The longer fibers in composite is greater composite resilience;
- To obtain ceramic composite we used 7 wt.% SiC_f independently on number of layers. The most durable sample had 7 layers.

Acknowledgments
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