FABRICATION OF C/ZRB$_2$-SIC COMPOSITES USING PRECERAMIC PREPREGS*

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In recent years, there has been a growing interest in the development and application of zirconium diboride-based ceramics. Due to the high melting point (3246°C), thermal conductivity (70-100 W/(m·K), chemical stability and relatively low specific density (6.08 g/cm^3), ZrB_2-based ceramics are intensively investigated for the development of products designed to operate in extreme conditions. Introduction of the second component (SiC) allows to increase oxidation stability of ceramics based on ZrB_2, which allows to consider such material as a structural one capable to withstand extreme temperatures, mechanical loads and aggressive environment. Low crack resistance of ZrB_2-SiC ceramics causes the necessity of obtaining such ultrahigh-temperature materials in the form of composites reinforced with continuous fibers.

A new method of ultrahigh-temperature composites formation with matrices based on zirconium, hafnium diborides/carbides reinforced with continuous carbon fibers was recently developed [1]. The main feature of the proposed approach is the stage of impregnation of carbon fiber with ceramic slurry and subsequent formation of flexible preceramic prepregs. Earlier the first results of the study of microstructure and mechanical properties of C/ZrB_2-SiC composites obtained by the new method of preceramic prepregs were presented [1, 2].

Further studies are required to investigate the formation of time-stable multicomponent preceramic slurries of refractory compounds, including hafnium and zirconium diborides, to clarify the correlation between the ratio of ceramic filler, organic binder, and solvents, the particle size of the dispersed phase with the rheological properties of the obtained slurries and to study the specifics of infiltration of the obtained slurries into the carbon fiber tow.

Literature data on the formation and rheological behavior of such slurries is sparse, irregular and limited by incomplete data on their composition. The most important characteristic of slurries, dynamic viscosity, which is crucial for understanding the patterns of infiltration into a porous body, is weakly covered in the literature.

The aim of this work is to investigate the formation of ZrB_2-based preceramic slurries and to search for the correlation between slurry composition and composite properties. C/ZrB_2-SiC composites were formed by preceramic prepreg method based on slurries of different compositions. The rheological properties of a wide range of ZrB_2-based suspensions were studied and their influence on the properties of the composites was established.

It has been shown that the matrix resin solutions behave as dilatant liquids up to 40-45 vol% of resin and introduction of ceramic filler provide a pseudoplastic behavior. Thus it is possible to regulate the nature of the slurry behavior and its dynamic viscosity by varying the volume fractions of ceramic filler and resin. Composites formed by preceramic prepreg method based on slurries with higher proportion of solvents and lower viscosity exhibit higher volume fraction of reinforcing phase. Phase composition of the matrix can be controlled by varying the filler/resin ratio in the slurry. Increasing the volume fraction of ZrB_2 phase in the matrix augments the porosity of the resulting composites.

REFERENCES

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