

INVESTIGATION OF PROCESSES OCCURRING AT THE IRIIDIUM/SILICON CARBIDE INTERFACE IN A WIDE TEMPERATURE RANGE*

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Silicon carbide, due to a combination of unique properties, is an integral component of high-temperature structural materials. However, the manufacture of products of complex shapes from SiC, due to its high hardness (9 – 9.5 according to Mohs), is a very laborious and difficult task. There is a concept of connecting two or more parts into one with the help of an intermediate metal layer. SiC-Me couples are currently developed for these purposes, where Ti, Mo, V, Cr, etc. act as the metal, and have insufficient oxidative stability and low impact strength, which is a consequence of the formation of a brittle carbide phase [1]. The use of iridium, a noble metal that does not form carbides and has an extremely high oxidative stability up to T_m (2446 °C), is the most promising approach to solving this problem [2]. The combination of components such as SiC and Ir is also of great interest in the fields of nuclear power, high temperature electronics and aerospace. Information on the Ir-SiC system is very scarce and contradictory [3,4,5], so there is a need to study the physicochemical processes that occur at the Ir/SiC interface.

The aim of this work is a physicochemical study of the interaction features at the Ir/SiC interface using diffusion couples in a wide temperature range. To achieve this goal, samples were obtained by heat treatment of diffusion couples of iridium - silicon carbide ceramics in the range of 1300 – 1800 °C and different holding times. The interaction products were studied by a complex of physicochemical methods of analysis, including XRD, SEM/EDX, TG-DTA, and Raman spectroscopy.

It has been established that the type of interaction changes with increasing temperature from solid-phase ($T \leq 1400^\circ\text{C}$) to interaction involving the liquid phase ($T > 1400^\circ\text{C}$), as evidenced by the presence of a drop-like layer. In the solid phase regime, the following sequence of phase layers is observed: SiC / IrSi+C / IrSi (without C) / Ir₃Si₂ / Eutectoid: «Ir₃Si₂+Ir₃Si» / Ir₃Si / Ir, which is consistent with the phase diagram of the Ir-Si system. It should be noted that the eutectoid layer was formed as a result of the decomposition of the Ir₂Si phase during cooling, according to the data of the Ir-Si phase diagram. Judging by the phase sizes and their dynamic growth, we can conclude that the diffusion of iridium atoms is much faster than the diffusion of silicon atoms. The dependence of the sizes of layers of product phases does not follow a parabolic law, from which we can conclude that under these conditions the reaction is controlled by kinetics. Based on the data obtained, an interaction model was proposed. The evolution of morphology during solid-state reaction and reaction with the participation of a liquid was also studied. Sequential alternation of dense IrSi bands and bands with a random distribution of IrSi and carbon grains was found. The band width of dense IrSi increases with distance from the reaction front. The degree of order and the size of carbon agglomerates increase with distance from the reaction front. For the first time, the values of CTE and microhardness of iridium silicides formed in the reaction were obtained. It was found that the microhardness of silicides is, on average, 2 times higher than the microhardness of iridium. The values of CTE and volumes of products do not differ much from the initial reagents.

The data obtained can be in demand in the fields of materials science related to the creation of products that are resistant to aggressive environments, high temperatures, abrasive wear, and high mechanical loads.

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