DEPOSITION IN MICROWAVE PLASMA AND PERFORMANCE OF POLYCRYSTALLINE DIAMOND COATINGS WITH HIGH ADHESION ON SIALON CERAMICS CUTTING TOOLS[i]

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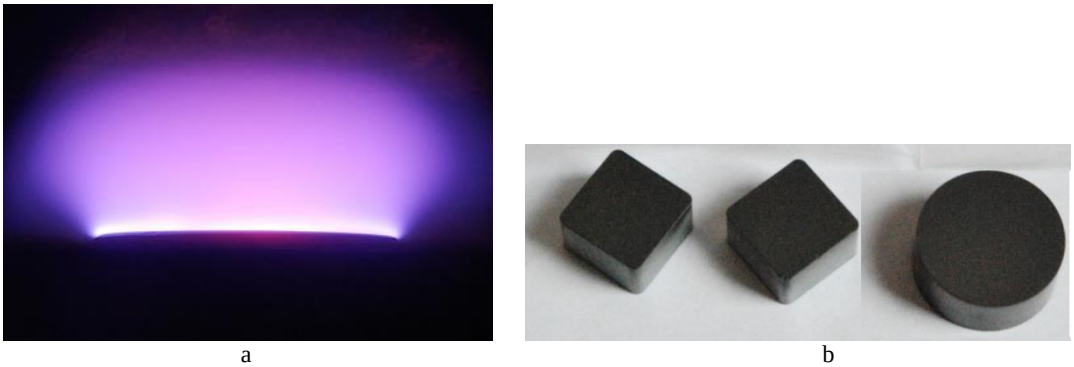
Applications of new composite materials with high strength for aerospace, automotive, and other industries often meet a problem of their mechanical treatment. The presence of extremely hard components in the composites reduces drastically the lifetime of cutting tools, including ceramic tools. As for tools directly coated with a thin chemical vapor deposition (CVD) diamond film, they can also fail due to insufficient adhesion resulting in the diamond coating peeling. Experimental studies have shown that the surface roughness and its chemical composition are of primary importance for the adhesion of diamond coatings to ceramic base.

Here we describe the process for coating of a group of ceramic (SIALON) substrates (together loaded in reactor) with polycrystalline diamond films in microwave plasma in $H_2/CH_4/SiH_4$ gas mixture. By controlling the configuration of the microwave field in CVD reactor ARDIS–100 (Optosystems Ltd, 2.45 GHz) using a specially designed substrate holder, cutting inserts with uniform diamond layer and high adhesion to the substrate are obtained (Fig.1). Single layer diamond films and multilayer (with diamond grain size varied) films were produced using different diamond growth protocols. The critical load >41 N was measured in adhesion test for the coatings by scratching method.



a b

Fig.1. a) Process of diamond coating in microwave discharge; b) SIALON inserts with diamond coating.

Cutting performance of the tools was significantly improved by reducing the friction coefficient. For different samples of bare (uncoated) SIALON ceramics, it varied within 0.33-0.44, while with the coating the friction coefficient decreased by 6-8 times down to 0.04-0.07.

The durability of the diamond coated SIALON inserts has been tested in dry turning of Al-Si alloy. Within the acceptable working parameters of machining the multi-layer coated diamond tools showed better performance compared to those with other types of coatings. Wear of the incisors on the back surface occurs gradually, the worn surfaces had a smooth appearance characteristic for micro-scale abrasive wear mechanism. The criterion wear of 0.4 mm in width, that defines the complete tool-life, still was not achieved with the cutting path of at least 2000 m.

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