Surface Structuring of SiSiC by Jet-Electrochemical Machining

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Abstract

SiC-based ceramics are characterized by high corrosion and wear resistance and are therefore often used e.g. as face seals or friction bearings in pumps and propulsion systems. Micro surface structuring of such components offers an improvement in tribological characteristics. But since SiC-based ceramics exhibit extremely high hardness, they are very difficult to be machined by mechanical techniques resulting in high tool wear. Comparatively high melting temperatures lead to long machining times when using thermal ablating technologies such as laser beam machining or electrical discharge machining.

Thus, as an alternative, electrochemical machining (ECM) is analyzed in this study. ECM is an ablating technology without mechanical contact between tool and workpiece, hence, there is no process-related tool wear. The removal process takes place at room temperature, which results in only negligible thermal impact on the tool and workpiece material. Applying a closed electrolytic free jet (Jet-ECM) offers the possibility for surface structuring without need for masking nor complicated form electrodes.

To ensure the exchange of electrical charge required for the removal, a fundamental pre-condition for ECM is a sufficiently high electrical conductivity of the workpiece material. Thus, ROCAR®SIF SiSiC from CeramTec, a material doped with ≤ 3 ppm Cu and a content of (9...17) % of Si was chosen, which exhibits a conductivity of approximately 1 S/cm. Since the comparatively high conductivity is provided by secondary phases due to doping and the high content of Si, a homogeneous EC removal is hardly achievable. High current densities are known to lead to more homogeneous EC removals resulting in low surface roughness. Thus, the present study focuses on the analysis of the removal geometry and the surface roughness achieved with Jet-ECM at an average current density of approximately 200 A/cm² with reference to the electrolyte jet.

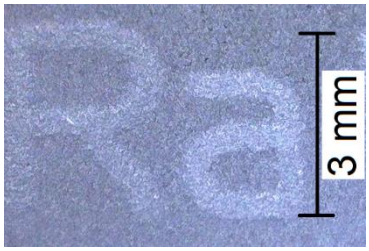

Figure 1: Jet-ECM removal on SiSiC