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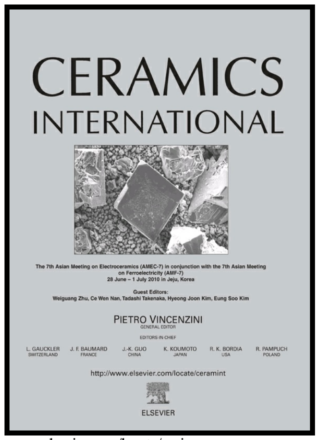

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Ultrasonic vibration mill-grinding of single-crystal silicon carbide for pressure sensor diaphragms

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Abstract

Single-crystal silicon carbide (SiC) has gained tremendous attention for harsh-environment sensor applications due to its high-temperature tolerance and chemical resistance. However, there are many technological challenges in the fabrication of single-crystal SiC sensing microstructures such as thin SiC diaphragms for pressure sensors. This paper presents an ultrasonic vibration mill-grinding (UVMG) technique for the fabrication of 6H-SiC sensor diaphragms. The fundamental machining characteristics of UVMG are investigated experimentally compared with conventional mill-grinding (CMG). The experimental results show that the axial grinding force in UVMG is reduced by 60-70% compared to that in CMG. In addition, the wheel loading is severe in CMG, while the issue of wheel loading is significantly alleviated in UVMG due to the discontinuous cutting characteristic achieved in this method. As a result, sharp increase of the axial grinding force, which is accompanied by the crack of SiC workpiece, happens frequently in CMG after a total grinding depth of 200 μm. By contrast, the axial grinding force is stable in UVMG during the total grinding depth of at least 900 μm. The ultrasonic vibration in UVMG results in rough surface finish due to the material-removal mechanism of brittle fracture. However, by taking the advantages of better machining stability in UVMG and better surface roughness in CMG, extremely thin SiC sensor diaphragms with satisfactory surface quality can be achieved. Finally, we demonstrate the successful fabrication of a thin SiC diaphragm with a thickness of