

Wear characteristics of PCBN tools in ultra-precision machining of stainless steel at low cutting speeds

Abstract

Polycrystalline cubic boron nitride (PCBN) cutting tools are widely used in the ultra-precision machining of stainless steel mould inserts for the injection moulding of optical lenses. During the machining of a spherical or an aspherical profile on a mould insert, the cutting speed reduces significantly to approximately 0 as the cutting tool is fed towards the centre of the machined profile. This paper will report on experiments carried out to investigate the wear of various grades of PCBN tool in the ultra-precision machining of STAVAX (modified AISI 420 stainless steel) at low speeds. In the initial stage of machining, fine-scale cavities were formed on the rake face and as such, the damaged surface acted like a chip breaker and thus as a preferential site for crack initiation. Once a crack was initiated, it propagated along the grain boundaries leading to intergranular fracture. The experimental results show that the formation and extent of the surface fracture are greatly dependent on the cutting forces and the severity of abrasion on the rake face which are governed by the cutting temperature. The porosity, ductility and the bonding strength of the grains in the tool, apart from its thermal conductivity appear to have major influences on the fracture resistance of the tool.