THE SUMMARY OF Ph.D. DISSERTATION

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Title

Friction Reduction of Ceramic Surfaces by Micro-Dimple Patterning

Abstract

Advanced ceramics have long been expected to be new structural materials capable of replacing widely used engineering materials such as metals and plastics, due to their superior properties, i.e. high hardness, high wear resistance, high heat resistance, etc. Some researchers have identified that frictional surfaces with controlled porosity can exhibit excellent behavior in tribological applications. This study investigates the machining characteristics during abrasive jet machining of ceramic materials and the tribological properties of micro-dimpled ceramic surfaces under lubricated sliding conditions.

Chapter 1 summarizes the background and previous studies.

Chapter 2 evaluates the machinability of abrasive jet machining of engineering ceramics from both theoretical and empirical points of view. Model equations relating material removal and the properties of materials and projectiles were developed for the two cases involving machining with abrasives of both high and low hardness. It was verified that the experimental results agreed qualitatively with these equations. Furthermore, the influence of the projectile properties in terms of size and velocity could also be interpreted by the theoretical model.

Chapter 3 focuses more specifically on the response to particle impacts in abrasive jet machining of alumina ceramics machined with various abrasives. When GC abrasive was used, in particular, smooth surface morphology was obtained. The presence of a thin fine-grained surface layer was found, which was generated as a result of particle impact and played a role in enhancing the bending strength of the alumina material.

Chapter 4 describes the influence of abrasive jet machining on strength degradation. It was clarified that the material removal by micro brittle fracture did not necessarily degrade the strength of the material, because the scale of the machining defects was smaller than that of the pre-existing cracks. In addition, the surface morphology dimpled with the AJM technology did not lead to strength degradation of the ceramic material. These results verified that AJM has a high potential as a micro-machining technique for tribological applications.

Chapter 5 describes the frictional properties of micro-dimple patterned silicon nitride ceramics through pin-on-disk tests modeling the cam/follower interface. An appropriate dimple pattern could successfully reduce the friction coefficient by approximately 20 % as compared to a non-dimpled surface, as a result of the improved lubricating performance at the direct contact interface.

The results of this study are summarized in Chapter 6.