ADVANCED MACHINING TOWARDS IMPROVED MACHINABILITY OF DIFFICULT-TO-CUT MATERIALS

Edited by:
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Tel: +603-6188 1542 / 44 / 45 Fax: +603-6188 1543
EMAIL: iiumprinting@yahoo.com

Chapter 30

Implementation of High Speed of Silicon using Diamond Coated Tools with Air Blowing

A.K.M. Nurul Amin[1], Siti Nurshahida Mohd Nasir[2] & Noor Syairah Khalid [2]
Department of Manufacturing and Materials Engineering
Kulliyyah of Engineering, International Islamic University Malaysia
e-mail address of contacting author: akamin@iium.edu.my

1.0 INTRODUCTION

Ductile mode machining of silicon is hard to obtain due to the brittleness of silicon and hardness of tool materials. A brittle material will have little tendency to deform before it fractures when it is subjected to stress. Ceramic materials such as silicon carbide and silicon nitride are hard and brittle to be machined. According to Thimmaiah et al. [1] brittle materials are difficult to machine while maintaining the desired surface roughness, yet Sreejith [2] specified that ductile machining of brittle materials is possible under controlled machining conditions. This is supported by works of J. Yan et al. [3], which stated that silicon is nominally brittle material but can be deformed plastically in machining, yielding ductile chips under the influence of high hydrostatic pressure.

According to Mariayyah and Ravishankar [4], conventional grinding of these materials leaves micro-cracks and pits on the surface. Other than that, these materials insist on further finishing as lapping and polishing to ensure high quality surface finish. These finishing operations such processes can be avoided if the materials can be machined similar to metals in ductile regime machining. Recent machining studies on brittle materials such as silicon and germanium have shown that ductile regime machining using a single point diamond tool can produce a mirror-like finish wherein various machining parameters are provided and properly controlled such as spindle speed, depth of cut and feed rate, hence the material deforms plastically during machining.

D.J Stephenson [5] stated that in conventional single point diamond turning, ductile materials such as aluminum and copper are usually used as material for mirror quality surface products. With the recent use of the single point diamond turning, strong demands for the ultra-precision machining of brittle materials such as silicon, germanium and glass are increasing. Hence, many works concerned with the machining of the brittle material have been conducted. As a result of a ductile-to-brittle transition, it is not easy to machine brittle materials to obtain mirror quality surface in nature due to the occurrence of the fracture.

Y.S. Liao et al. [6] showed that in recent years, high speed machining (HSM) technology is becoming matured due to the advance of machine tool and control system. A higher metal removal rate is not the only advantage of HSM. It has the features of lower cutting force, improvement of the surface quality, no critical heat of the work piece, etc.