Optimizing the Machining Parameters in Glass Grinding Operation on the CNC Milling Machine for Best Surface Roughness

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Abstract. Glass is one of the most difficult materials to be machined due to its brittle nature and unique structure such that the fracture is often occurred during machining and the surface finish produced is often poor. CNC milling machine is possible to be used with several parameters making the machining process on the glass special compared to other machining process. However, the application of grinding process on the CNC milling machine would be an ideal solution in generating special products with good surface roughness. This paper studies how to optimize the different machining parameters in glass grinding operation on CNC machine seeking for best surface roughness. These parameters include the spindle speed, feed rate, depth of cut, lubrication mode, tool type, tool diameter and tool wear. To optimize these machining parameters in which the most significant parameters affecting the surface roughness can be identified, Taguchi optimization method is used with the orthogonal array of L 8(2^6). However, to obtain the most optimum parameters for best surface roughness, the signal to noise (S/N) response analysis and Pareto analysis of variance (ANOVA) methods are implemented. Finally, the confirmation test is carried out to investigate the improvement of the optimization. The results showed an improvement of 8.91% in the measured surface roughness.

Introduction

Glass is an amorphous solid that is a favored material for a lot of reasons. It resists chemical interactions, it is easy to recycle, it does not leach chemicals like plastics do, and it can withstand extremes of heat and cold, although not at the same time. There are many types of glassy materials available in the market, however, soda lime glass is the most prevalent type of glass as it is widely used and easily can be found in the market. Soda lime glass is also plays an essential role in industry such that, the demand for fabrication has been increasing to generate diversified functionalities on many applications [1-2]. Although some manufacturing processes such as chemical etching have been made to fabricate micro patterns on glass, the process takes a long time and is hazardous. Other approaches, therefore, are required to manufacture glass products at a high production rate, higher surface quality and easier operations [3].

Recently, many researchers have studied the machining processes for these important brittle materials [4-6]. Most have tried to machine glass using CNC milling machine and focused on the transition from ductile to brittle mode. According to the research, glass can be machined in a ductile mode when the undeformed chip thickness is less than a micrometer. Machining processes, however, have not yet attained at a high production rate. Therefore, the application of grinding process on the CNC milling machine would make it an extremely efficient process but the poor surface finish produced is a common problem when machining materials harder than 50 HRC [1-3].