A STUDY OF LAPPING PARAMETERS TO REDUCE POLISHING TIME OF OPTICAL GLASS

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In the name of Allah, Most Gracious, Most Merciful

All praise and thanks are due to Allah Almighty and peace and blessings be upon His Messenger

The results of this effort are truly dedicated to my mother and father whose example as devoted professionals, as well as, parents taught me to be perseverant, responsible and loyal to my belief.

To my father and mother for their support, encouragement, sacrifice, and especially for their love.

Thank you all and this work is for YOU.

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ABSTRACT

Machining of hard and brittle material always pose problems such as rough surface, cracks, sub-surface damage and residual stress mainly due to its brittle nature. In recent year researchers and manufactures have put in of lot effort to design and fabricate highly precise device to achieve low tolerance, better surface finish and low sub-surface damage at reduced cost. In this study ultrasonic grinding was used to grind flat surface on the BK7 glass. Only feed rate was varied during grinding, ie. 0.5, 1.5, 2.5, and 3.5mm/min while other parameters such depth of cut (5μm), frequency (20kHz) and spindle speed (1000rpm) were fixed. The four ground samples were lapped at various table speeds and followed by polishing operations at fixed conditions. Surface roughness and surface morphology of the samples were evaluated after each process. It is found that surface roughness increases when the feed rate increased. Higher lapping speed (50rpm) remove material faster and fines better surface finish than lower speeds. Saturation point of surface roughness occurs at 10 minutes lapping time. The finest polishing surface achievable using less rigid machine was 38nm. It is expected lower Ra could be obtained after polishing if the same lapping and polishing machine is used for both processes.

ABSTRAK

Pemensinan bahan keras dan rapuh sentiasa memberi masalah seperti permukaan kasar, keretakan, kerosakan bawah permukaan dan tegasan tinggal yanh mana sebahagian besarnya disebabkan oleh sifatnya yang rapuh. Sejak beberapa tahun kebelakangan ini, penyelidik dan pengeluar telah berusaha keras untuk merekabentuk dan memasang peranti berketepatan tinggi untuk mencapai tahap had terima yang rendah, kemasan permukaan yang lebih baik dan keedaan kerosakan bawah permukaan yang rendah pada kos yang rendah. Dalam kajian ini, pencanaian ultrasonik telah digunakan untuk mencanai permukaan rata ke atas kaca BK7. Hanya kadar uluran sahaja yang diubah semasa mencanai, iaitu. 0.5, 1.5, 2.5 dan 3.5mm/min, sementara lain-lain parameter seperti kedalaman pemotongan (5µm), frekuensi ultrasonik (20kHz) dan kelajuan spindal (1000 rpm) telah ditetapkan. Keempat-empat sampel yang dicanai talah dipelas pada beberapa kelajuan meja dan diikuti dengan operasi penggilapan pada keadaan tetap. Kekasaran permukaan dan morfologi permukaan semua sampel telah dinilai selepas setiap proses. Didapati bahawa kekasaran permukaan meningkat apabila kadar uluran ditingkatkan. Kelajuan mempelas yang lebih tinggi (50rpm) dapat membuang bahan dengan lebih cepat dan memberikan kemasan permukaan yang lebih baik dari kelajuan mempelas yang rendah. Tetik tepu kekasaran permukaan berlaku pada minit ke 10 masa mempelas. Kemasan permukaan gilapan yang terhalus yang boleh dicapai menggunakan mesin yang kurang tegar adalah 38nm. Adalah dijangkakan nilai Ra yang lebilh rendah boleh diperolehi selepas penggilapan jika mesin mempelas dan menggilap yang sama digunakan bagi kedua-dua proses.

LIST OF CONTENTNS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Overview

Optical components can be found in infra-red systems, beam deflectors in synchrotron radiation facilities and optical lenses. They are either in spherical or flat surfaces, and require high precision in shape accuracy with low surface roughness values (Zhong and Venkatesh, 1994).

Being made of advanced ceramics or optical glass, they are very difficult to machine and shape because of their brittleness, extreme hardness to meet high requirement on the high shape accuracy and the low surface roughness values in certain applications (Zhong, 2002). Researchers have made much effort to manufacture highly precise devices with good surface finish, and low sub-surface damage (Van Ligten and Venkatesh, 1985; Venkatesh and Zohng, 1995).

In order to reduce the total manufacture time, it is preferable to obtain better ground/lapped surface, with less fracture mode as possible in order to reduce polishing time.

1.2 Problem statement

Lapping and polishing processes are important steps involved in optical glass manufacturing activities. Researchers and manufacturers have put lot of efforts for achieving low tolerance, better surface finish with defect-free in order to reduce manufacturing cost.

Being made of glass, this material is well known for its difficulty to machine and shape at higher accuracy because of their brittleness nature and possessive an extreme hardness.

Optical glass requires these traditional steps of processing, ie. grinding, lapping and polishing. Among these, polishing process is the most time consuming process. Polishing time is very much limited dependent on the state of prior two process, ie. grinding and lapping. Optimization on grinding and lapping will reduce significantly the polishing time. However, there are many parameters contribute to the successful of grinding and lapping. Among others, the grit size of abrasive, the speed (spindle and table), feed etc. These parameters also depend on machine rigidity which partly contributes to the final finishing of the work piece. To date, there are very little literature reports on the steps of manufacturing optical flat which can be considered as confidential to many manufactures.

1.3 Objective of study

The objectives of this project as follows**:**

i. To evaluate the effect of feed rates on surface roughness of ground BK7 glass.
ii. To evaluate the effect of table speeds on surface surfaces of lapped BK7 glass.
iii. To propose a feasible range of polishing time for BK7 glass.

1.4 Scope of the study

The scopes of study are as follows:

i. BK7 optical glass is selected for the study.
ii. Ultrasonic assisted grinding is used for preparing the initial surface before lapping operation.
iii. Al_2O_3 abrasive slurry of 9µm is used in the lapping operation.
iv. Colloidal silica of 3µm is used as polishing slurry.
v. Load is fixed during lapping and polishing operations.

1.5 Organization of the thesis

First Chapter describes introduction, followed by the problem statement, objective of the study and scope of study. The second Chapter prepared the back ground on optical glass, optical flat and over view the principles of grinding, lapping and polishing process optical glass. Third Chapter is details out methodology and experimental works. Results and discussion are discussed in the Chapter four. Chapter five discuses conclusions and recommendations for future work.