

Magnetic field-assisted batch polishing of freeform surfaces

C.J. Wang¹, Y.M. Loh¹, C.F. Cheung¹, L.T. Ho¹

¹State Key Laboratory of Ultra-precision Machining Technology, Department of Industrial and Systems Engineering, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China

chunjin.wang@polyu.edu.hk

Abstract

The increasing demand of the superfinished freeform surfaces has stimulated the development and upgrade of the precision polishing technology. However, current ultra-precision polishing methods usually polish the workpiece one-by-one, leading to low production efficiency and high polishing cost. Even though some batch polishing methods have been developed for polishing a number of workpieces simultaneously, it is difficult for them to obtain high form accuracy, as well as nanometre scale surface roughness. Hence, this study presents a novel magnetic field-assisted batch polishing (MABP) method which not only implements nanometre scale batch polishing of freeform surfaces, but also achieves high form maintainability.

The MABP method makes use of a magnetic field applied by two pairs of magnetic poles rotating outside an annular chamber mounted with a number of workpieces concurrently. The rotating magnetic brushes comprise magnetic particles and abrasives formed inside the chamber which impinge and remove materials from the workpiece. A theoretical and experimental investigation of the material removal in MABP process is conducted, including kinematic analysis of the brush motion, simulation of the magnetic field distribution and material removal distribution model. Moreover, experiments on both normal surfaces and freeform surfaces are also carried out. The results indicate that the MABP method is effective to obtain nanometric surface roughness together with micrometric form accuracy in the batch polishing of both normal and freeform surfaces. This study sheds the light for the application of MABP in batch polishing of optical components and moulds, functional structured surfaces, turbine blades, dental crowns, surgical knives, high-end jewellery, etc.

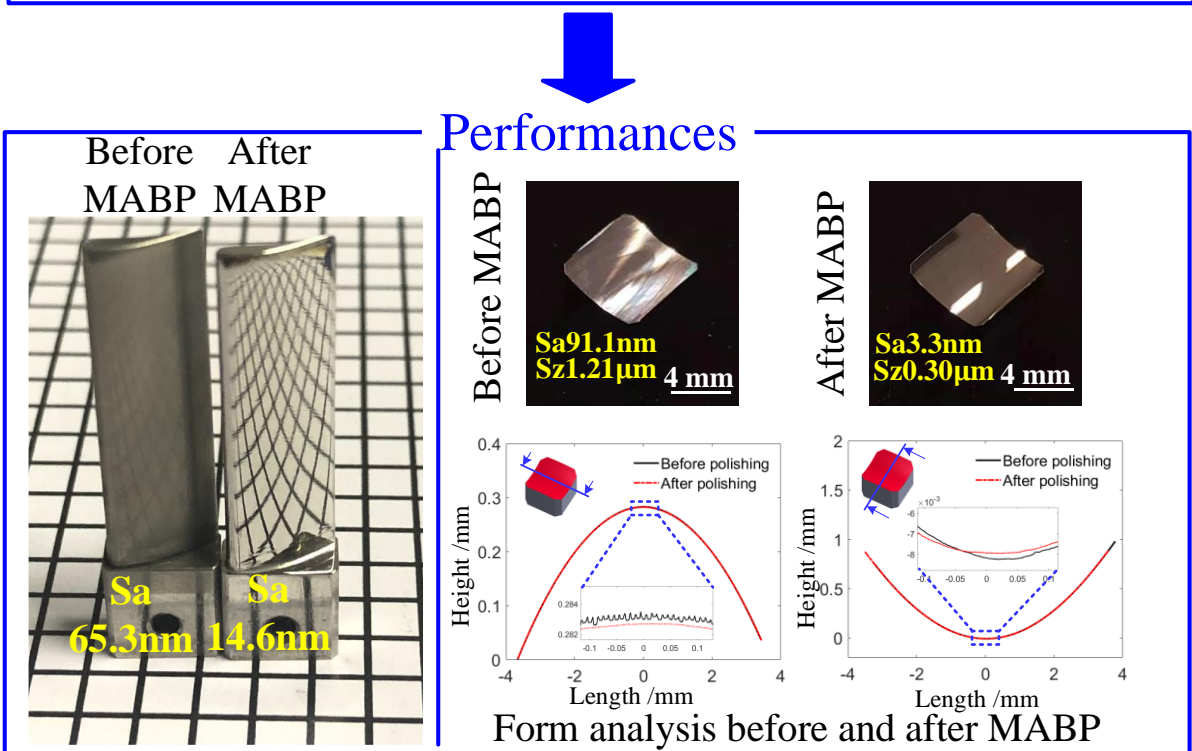
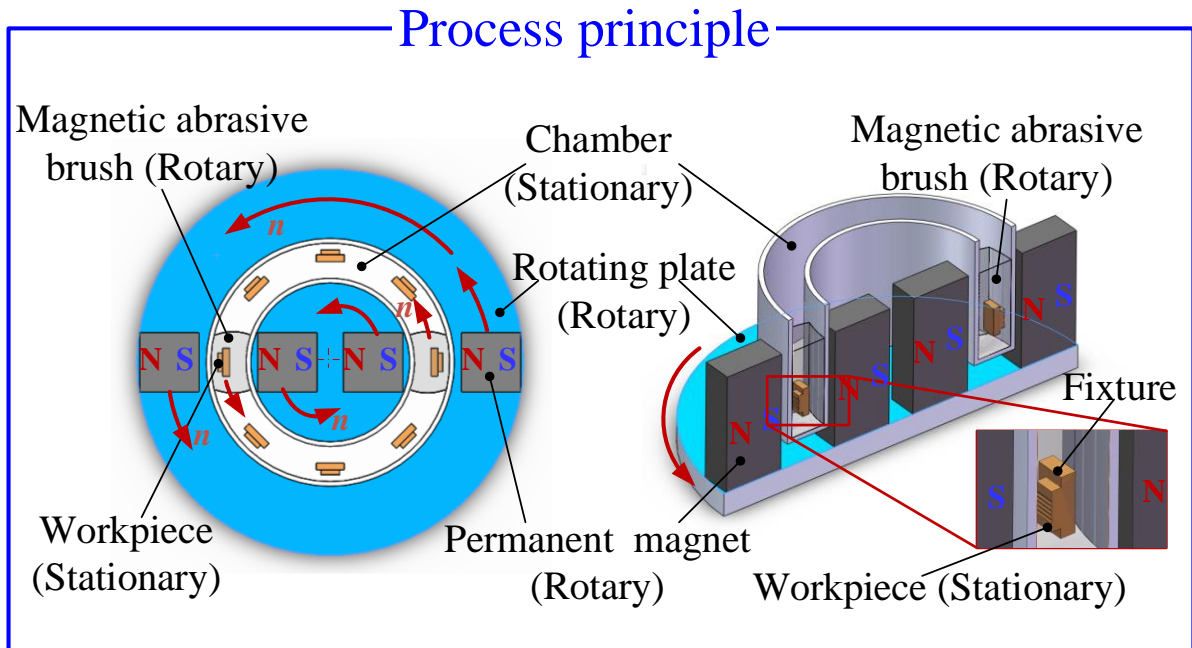


Figure 1: Process principle of the magnetic field-assisted batch polishing (MABP) method and its performance on freeform surfaces