Int J Adv Manuf Technol (2013) 68:631–640
DOI 10.1007/s00170-013-4783-6

ORIGINAL ARTICLE

Comprehensive performance evaluation of the magnetic abrasive particles

Z. Q. Liu · Y. Chen · Y. J. Li · X. Zhang

Received: 2 July 2012 / Accepted: 21 January 2013 / Published online: 5 February 2013

Abstract Magnetic abrasive finishing (MAF) is one of the nontraditional machining processes that have been studied to improve the surface quality and deburr the workpiece. The magnetic abrasive particles (MAPs) as the machining tool of MAF influence the finishing efficiency and the final surface quality. In this study, in order to evaluate the comprehensive performance of the sintered MAPs with the simply mixed MAPs, the surface morphologic structure and the particulate compositions of the sintered MAPs were observed and tested by scanning electron microscopy with energy spectrum analysis. The *M–H* curves of the two kinds of MAPs were tested through a superconducting quantum interference device. The actual magnetic flux density in the working gap was measured by Gauss meter, and the results showed that the magnetic properties of the sintered MAPs are superior to the simply mixed MAPs. At last, through the different finished surface texture and motion analysis combining with all the measurements, results proved that the finishing ability of sintered MAPs is greater than simply mixed MAPs.

Keywords Magnetic abrasive particles · Magnetic abrasive finishing · Finishing efficiency · Surface quality

1 Introduction

The magnetic abrasive particles (MAPs) play a significant role in magnetic abrasive finishing (MAF) process. As the machining tool, the MAPs consist of ferromagnetic particles and hard abrasive particles, which can be magnetized in the magnetic field and with a certain finishing ability. When the abrasive particles follow the ferromagnetic particles motion on the workpiece surface, the finishing is done. The main role of the ferromagnetic particles in MAF is that it restrains the abrasive particles flying out the machining area and the abrasive particles serve as the cutters [1, 2]. So, in order to develop the MAF process, it must sharpen the finishing tool first. There are many methods for the MAP preparation, such as simply mixing method, sintering method, bonding method, plasma spray, laser sintering method, etc. [3–9]. The ferromagnetic particle used in all these studies is iron (Fe); the abrasive particles are mainly silicon carbide (SiC), aluminum oxide (Al_2O_3), boron nitride, etc. Currently, the iron-based aluminum oxide magnetic abrasive is commercially available MAP in Japan [5]. According to the physical structure, the MAPs produced by the previous researches can be divided into two groups: one is the mechanical mixture and the other is the concrete composite particle. The mechanical mixture of the MAPs has the merits of easy making and low cost; however, the abrasive particles of the simply mixed MAPs can always detach from the finishing area while the magnetic force of the ferromagnetic particles cannot keep it, especially during finishing the curved surface workpiece. The sintered MAP as one kind of composite particle has been used by most of the researchers and gives highest surface finish on most of the work materials [10]. In recent years, many studies focus on the parametric optimization of MAF for the tiny tube inner surface, plate, and free-form surface. In those studies, the influencing factors such as the working gap, the rotation speed, the magnetic field, the MAP mesh, etc. for improving the MAF efficiency and surface roughness had been discussed [11–15]. Singh et al. studied the forces acting during MAF process and used the unbonded magnetic abrasive particles, which are a mixture of silicon carbide abrasive (mesh no. 600) and ferromagnetic iron particles (mesh no. 300) in the ratio of

Z. Q. Liu · Y. Chen (✉) · Y. J. Li · X. Zhang
Institute of Advanced Grinding Technology, University of Science and Technology Liaoning, Anshan, China
e-mail: cy1234cy@yahoo.com.cn
URL: http://202.199.240.28/mx/