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Author: Shun-Tong Chen Ming-Chieh Yeh

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## Development of an in-situ high-precision micro-hole finishing technique

Shun-Tong Chen<sup>1</sup>, Ming-Chieh Yeh<sup>2</sup>

<sup>1</sup>Professor, Department of Mechatronic Engineering, National Taiwan Normal University

<sup>2</sup>Graduate student, Department of Mechatronic Engineering, National Taiwan Normal University

E-mail: chenst@ntnu.edu.tw

### Abstract

This study presents the development of an in-situ hybrid micro-manufacturing process for making a novel micro-tool for the fabrication of a high-precision micro-hole of 200  $\mu\text{m}$  in diameter in difficult-to-machine material. The hybrid approach consists of rotary micro-EDM, micro-EDM peck-drilling, co-deposition, reverse micro-w-EDM, and micro-honing. These techniques can all be conducted on a single machining center allowing for in-situ micro-manufacturing. On the basis of the concept of a 'machining center', a horizontal/vertical dual-usage high-precision headstock and a hybrid work-tank with modularized design are devised. A novel microgrinding-tool which has an invert-tapered forked microstructure with central-symmetry and radial-elasticity is designed and fabricated using the hybrid processes. By applying the principle of cantilever beam support, the microgrinding-tool is employed for honing a micro-hole on SKD11 cold-working steel, achieving micro-scale material removal. All working coordinates are recorded during the process, the micro-tool and workpiece do not need to be unloaded and repositioned until all planned tasks are completed. Experimental results demonstrate that flatness of the hole-wall, circularity, and surface roughness of the honed micro-hole are 1  $\mu\text{m}$ , 0.5  $\mu\text{m}$  and Ra 0.032  $\mu\text{m}$ , respectively. Approaches to the factors influencing formation and accuracy of the micro-tool involving surface topography, current density in co-deposition, wire tension, rotation speed in honing, and tool longevity are all evaluated in detail.

**Keywords:** In-situ, micro-manufacturing processes, micro-tool, micro-hole

### 1. Introduction

The trend toward miniaturization in product design has propelled a revolution in miniature manufacturing technologies. Accordingly, micro-part, micro-tool, and micro-mould

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