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

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Abstract

This study presentsthedevelopment of an in-situhybrid micro-manufacturing process for making a novelmicro-tool for the fabrication of a high-precision micro-hole of 200μm in diameterin difficult-to-machine material.The hybrid approach consists of rotary micro-EDM, micro-EDM peck-drilling, co-deposition, reversemicro-w-EDM, and micro-honing. These techniquescan 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-taperedforked microstructure with central-symmetry and radial-elasticityis designed and fabricated using the hybrid processes. By applying theprinciple of cantilever beamsupport, the microgrinding-tool is employed for honing a micro-holeon 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 are1μm, 0.5μm and Ra0.032μm, respectively. Approaches tothe factors influencingformation and accuracy of the micro-toolinvolvingsurface topography, current density in co-deposition, wire tension, rotation speedin 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 arevolution in miniature manufacturing technologies.Accordingly,micro-part, micro-tool, and micro-mould