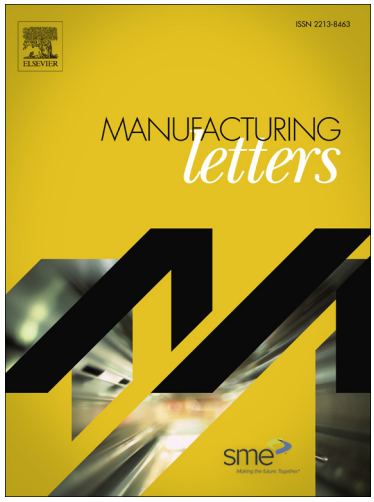

Letters

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Manufacturing of Hourglass-Shaped Through Holes with Varying Diameters at Different Depths by Dual-Pulse Laser Drilling and Laser-Induced Plasma-Hole Interaction

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Abstract: Microholes in a metal with diameters varying *unusually* at different hole depths (e.g., microholes with a decreasing and then increasing diameter with the depth) have important applications. This paper reports studies on a novel method of drilling such microholes in a metal, which is through "double-pulse" percussion laser drilling followed by laser-induced plasma (from a backing plate placed behind the workpiece) – hole interaction. Using this method, a through microhole has been produced in a metal workpiece, which has similar diameters at the hole entrance and exit, but a much smaller diameter at a certain waist section inside the hole.

Keywords: laser micromachining; laser drilling

1. Introduction

Microholes in a metal with diameters varying *unusually* at different hole depths have important applications. For example, a microhole, whose diameter first decreases and then increases with the depth (that is, in an hourglass shape), may find applications in diesel engine fuel injectors for enhanced fuel efficiency and reduced emission [1] (where a small hole diameter is also often desirable for the fuel efficiency enhancement). Laser machining [2-4] is one important method to produce microholes, and has several advantages such as high spatial resolution, no mechanical drilling-tool wear problem and good flexibility, etc. Some previous investigations were reported in the literature about laser drilling of holes in metals with unusually varying diameters at different hole depths, such as a hole with a reverse taper or a decreasing and

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