CHAPTER NUMBER

MICRO ELETRO DISCHARGE MILLING FOR MICROFABRICATION

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1 INTRODUCTION

Miniaturization of product is increasingly in demand for applications in numerous fields, such as aerospace, automotive, biomedical, healthcare, electronics, environmental, communications and consumer products. Researchers have been working on the microsystems that promise to enhance health care, quality of life and economic growth. Some examples are micro-channels for micro fuel cell, lab-on-chips, shape memory alloy 'stents', fluidic graphite channels for fuel cell applications, miniature actuators and sensors, medical devices, etc. (Madou, 2002; Hsu, 2002). Thus, miniaturization technologies are perceived as potential key technologies.

One bottleneck of product miniaturization is the lack of simpler and cheaper fabrication techniques. Currently the common techniques are based on silicon processing techniques, where silicon-based materials are processed through wet and dry chemical etching. These techniques are suitable for microelectronics, limited to few silicon-based materials and restricted to simple two dimensional (2D) or pseudo three dimensional (2.5D) planar geometries. Other fabrication processes, such as LiGA (lithography, electroforming and molding), laser, ultrasonic, focused ion beam (FIB), micro electro discharge machining (EDM), mechanical micromilling, etc. are expensive and required high capital investment. Moreover these processes are limited to selected materials and low throughput (Ehmann et al. 2002).

A less expensive and simpler microfabrication technique is sought to produce commercially viable microcomponents. Micro electro discharge (ED) milling, a new branch of EDM, has potential to fabricate functional microcomponents. The influences of micro ED milling process parameters on surface roughness, tool wear ratio and material removal rate are not fully identified yet. Therefore, modeling of ED milling process parameters for surface roughness, tool wear ratio and material removal rate are necessary.

1.1 Micro Electro Discharge Machining

EDM has been successfully used for micromachining with high precision regardless of the hardness of work piece material. It uses the removal phenomenon of electrical discharges in a dielectric fluid. Two conductive electrodes, one being the tool and the other the workpiece, are immersed in a liquid dielectric. A series of voltage pulses are applied between the electrodes, which are separated by a small gap. A localized breakdown of the dielectric occurs and sparks are generated across the inter-electrode gap, usually at regions where the local electric field strength is highest. Plasma channels towards workpiece are formed during the discharge and high speed electrons come into collision with the workpiece. Each spark erodes a small amount of work material by melting and vaporizing from the surface of both the electrodes. The momentary local plasma column temperature can reach as high as 40,000 K (DiBitonto et al., 1989).

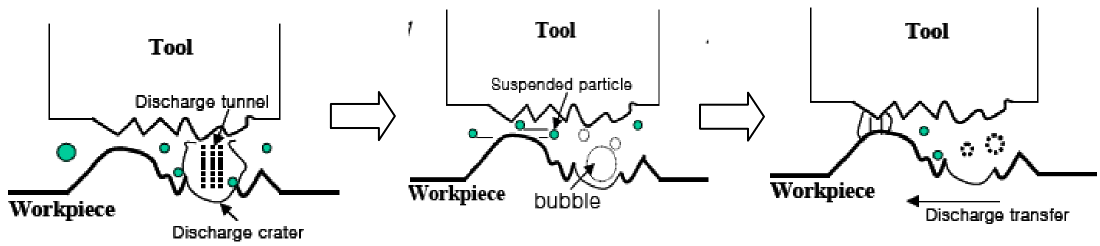

Figure 1.1: Schematic of EDM principle (Kim et al., 2005)