

A Novel Pixelated Electrodeposition Tool for the Microfabrication of 3-D Metal Microstructures

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A pixelated electrodeposition tool for fabricating complex three-dimensional metal microstructures is described. Each pixel of the tool consists of an independently controlled counter electrode placed within a fluid injector. We have fabricated a working prototype, and have theoretically explored the effects of several design and operating variables on its operation. Simulations of a 2-D analog of the fabricated device were conducted assuming a primary current distribution using a finite element package (PDE Toolbox) in the Matlab V. The theoretical results served as a qualitative guide in the fabrication and operation of the working prototype. Design characteristics necessary for attaining high-resolution deposition, and operating conditions necessary for attaining both high-resolution and rapid low-resolution deposition, are discussed. At present, the lateral resolution limit attainable by the tool is on the 100 micron scale, with vertical resolution in the sub-micron range.

Figure 1 shows a schematic representation of the electrodeposition head. Localized electrodeposition is achieved by independently activating selected electrodes within a 64-channel electrode-array. Coordination of electrolyte flow, current density, and the head's position above the substrate is accomplished using custom LabView software and switching hardware in conjunction with a serial-controlled Cole-Parmer Ismatec pump, a GPIB-controlled EG&G/PAR 273 potentiostat, and a customized MaxNC 10 3-axis endmill. Varying the above three operating parameters allowed us to control the size and composition of the localized deposit, thereby enabling retained alloy to be electrodeposited alongside readily dissolved sacrificial alloy[1]. The entire deposit was subsequently immersed in a dilute acid bath, removing the sacrificial alloy and leaving behind a 3-dimensionally complex metal microstructure.

References

1. Leith, S.D. and D.T. Schwartz, *In-situ fabrication of sacrificial layers in electrodeposited NiFe microstructures*. Journal of Micromechanics and Microengineering, 1999. **9**(1): p. 97-104.

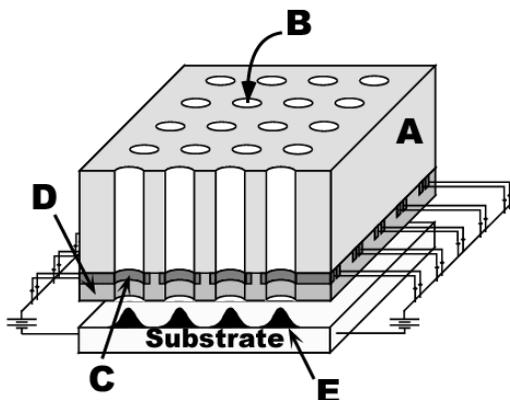


Figure 1. Schematic of the proposed tool: A) polymer support, B) flow-through electrolyte injectors, C) independently activated ring electrode, D) insulating layer of hard-baked photo resist, and E) the resulting localized metal deposit if all pixels were activated.