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# Direct writing of metal film via sputtering of micromachined electrodes

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**Abstract**

This paper presents the first micro-scale process for local deposition and direct writing of metal films through sputtering of a micromachined target electrode. The deposition process is achieved via a highly confined micro DC glow plasma generated between the electrode's tip and the substrate at atmospheric pressure. Using cylindrical microelectrodes with diameters down to 40 µm, a micro glow plasma is stably established to show local deposition of the material on silicon substrates. The controlled manipulation of microplasma enables direct film writing of arbitrary patterns, for thicknesses ranging from the 100-nm order up to several microns variable with the discharge and scanning conditions. The process and drawn films are characterized for copper, copper-tungsten alloy, and nickel-200 alloy to reveal its potential applicability for a wide range of target materials. The spectroscopic analysis indicates the films' elemental compositions to match well with those of the target materials. The direct drawing over non-planar substrates is also demonstrated to show the feasibility of 3D film printing using the developed process.

**Keywords:** Direct film writing; micro glow plasma; DC sputtering; local film deposition; three-dimensional printing