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Electromagnetic Coils for a 3000 Psi Hydraulic MEMS Valve Assembly

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Abstract Text:
Electromagnetic coils serve many roles in MEMS technologies such as actuators, microfluidics, sensors, energy harvesting, wireless communication, inductive heating, and biomedical applications. Coils can be made using traditional semiconductor manufacturing techniques requiring near UV lithography to define photoresist molds, electroforming metal into the molds, chemical mechanical planarization, assembly, and packaging. Non-traditional techniques such as LIGA using x-rays and soft LIGA using near UV exposures can create higher aspect ratio structures therefor maximizing coil performance and minimizing coil size.

Our work explores micro-fabrication techniques using soft LIGA lithography to create single sided and double-sided copper electroformed MEMS coils. The target coil feature sizes are 100+ micron in thickness of copper, 50 micron feature size, 50 micron gaps, and millimeters in total form factor. The microfabrication process including lithography, copper electrodeposition, and through wafer vias will be discussed along with lessons learned to meet the design criteria. Our goal is the demonstration of a single sided coil and double-sided coil device that could be assembled and arrayed across a 6 inch silicon wafer microfabrication process to create a hydraulic valve assembly. This would enable a digital flow control high-pressure hydraulic valve system capable of reaching 3000 psi. Ultimately this goal minimizes size and weight while increasing efficiency and maximizing power. The figure below depicts a cross sectional view of a single sided coil design assembled with a device layer having a through-wafer etch flow path.

Figure 1: Cross sectional view showing a single hydraulic MEMs valve assembly. A single sided MEMs coil on top, a suspended spring able to open and close the valve, and a thru-wafer fluid flow path.

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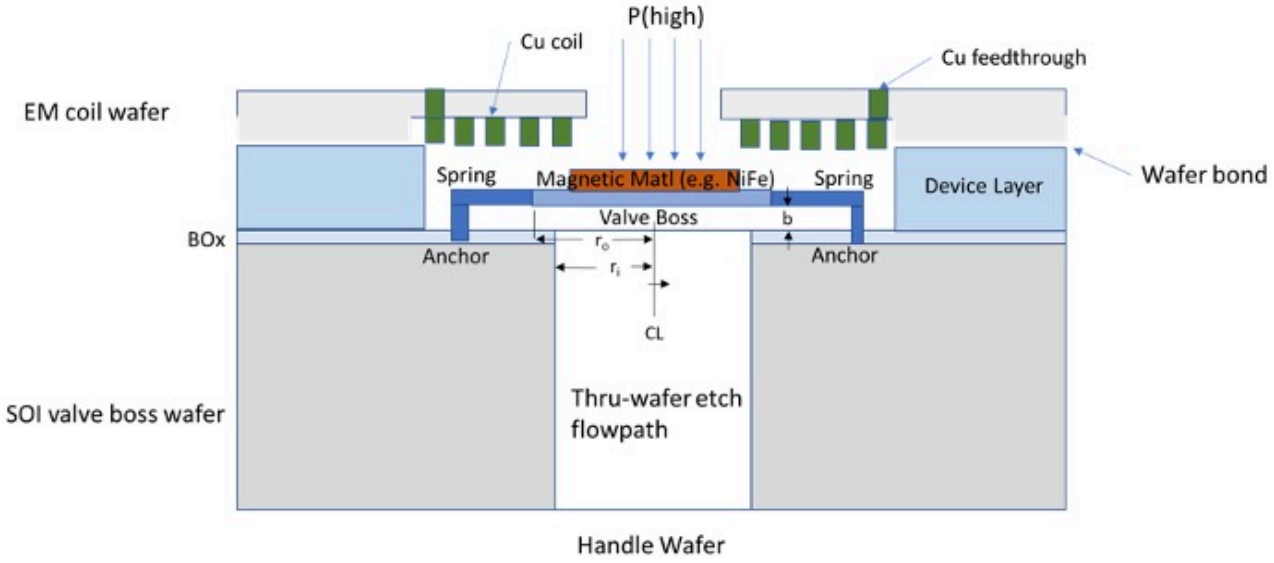

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