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Maskless Lithography with a DLP 3D Printer: A Low-Cost Approach to Microfabrication

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Abstract:

Maskless lithography is an alternative to traditional photolithography that offers greater flexibility, reduced costs, and faster prototyping by eliminating the need for physical masks. Photolithography relies on expensive mask fabrication and alignment processes, which makes it less efficient for constant design changes. In contrast, maskless lithography enables direct pattern exposure of photoresists using digital light projection (DLP), allowing for rapid design modifications. During the CORE Summer Research, a diode laser and galvo mirror system were used to expose photoresist. While this system had the potential for high-resolution patterning, challenges with complex galvo control and lack of test results prompted a shift in my approach.

To overcome these challenges, this study explores the use of a modified DLP 3D printer as a high-resolution UV projection source for maskless lithography. The DLP-based system projects UV light directly onto silicon wafers coated with photoresist. To ensure quality patterning, the wafers are first cleaned to ensure optimal adhesion of the photoresist, which is then applied via spin-coating to achieve a uniform layer. After a soft bake to remove solvents, the wafer is ready for exposure. To improve projection, the 3D printer is flipped upside down, allowing the UV light to be directed downward onto the wafer. By integrating an optical system, exposure quality is refined to achieve precise patterning on silicon wafers. Early findings show promising exposure consistency with ongoing improvements aimed at enhancing the image size and resolution. This work highlights the adaptability of DLP systems for lithography applications that provide a cost-effective alternative to photolithography.