Continuous roller photolithography and application to large area IR metamaterial fabrication

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Photolithography is undoubtedly the most widely used patterning method for the fabrication of micro- and nano- features, despite the recent development in some unconventional fabrication techniques that are poised to take over certain applications. But photolithography is still the main fabrication method in industry. For further step forward in many applied areas, however, large-area, continuous fabrication system needs to be developed. However photolithography has not been extended to large area continuous patterning like other printing technologies do. Current photolithography is based on wafer scale fabrication. Here we report the development of continuous roll type contact photolithography, which is terned photo roll lithography (PRL). Continuous patterning is achieved was by employing a flexible photomask with Cr patternings, which was fabricated by conventional photolithography method. Using a UV light source installed inside the roller, we demonstrate various patterns over large area by the PRL technique, which currently has a critical resolution ~ 500 nm, limited by light diffraction and pattern widening during developing process.

As an application, we report the fabrication of IR metamaterial in the form of metal-insulator-metal (MIM) structure by using PRL. The IR metamaterial is designed to absorb a specific range of wavelength in the IR range, which is achieved by patterning the top Al layer to an array of circular discs of varied diameters. . We present the initial results of IR filter and its properties which were achieved by a PRL prototype setup, which was designed to pattern on 400 cm^2. This study servers to prove the feasibility of PRL as a future mass production method.

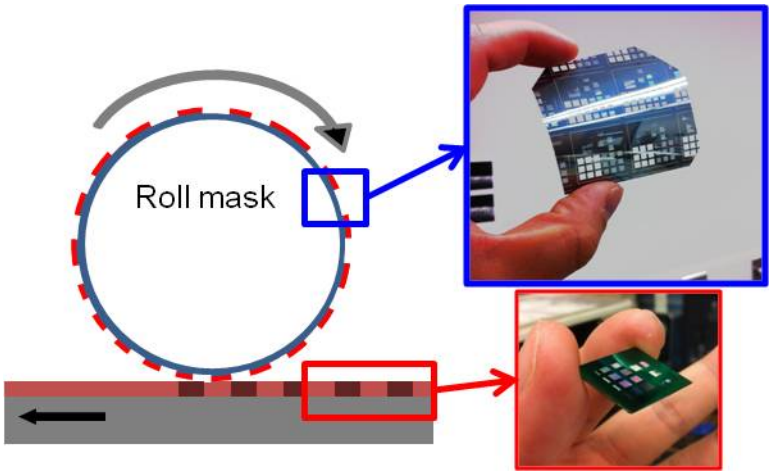

Figure 1: PRL schematic and results: Schematic of roll type phase lithography to make submicron mesh patterns for transparent metal electrode. Photo images shows flexible photomask(blue) and developed PR pattern(red).

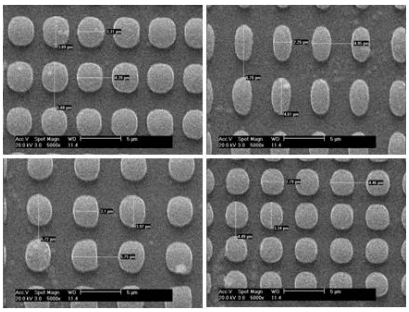

Figure 2. SEM images represent a MIM pattern after lithography and wet etching

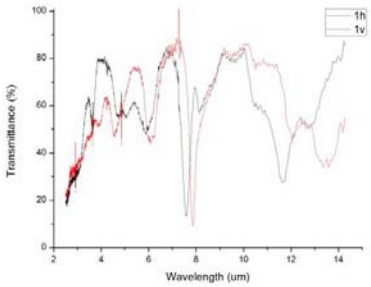

Figure 3. IR filter performance of IR filter is shown in graph.