Periodic metallic structures fabricated by coherent Talbot lithography in a table top system

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We present a defect tolerant Extreme Ultraviolet (EUV) lithography technique based on the utilization of the Talbot effect. The method renders error-free prints, regardless of existence of defects in the mask. The technique combined with coherent illumination from a compact EUV laser constitutes a compact lithography tool for nanopatterning.

The photo-lithographic approach we present is based on the self-imaging produced when a periodic transmission mask is illuminated with a coherent light beam, known as Talbot effect. [1]. This classic optical effect was also used in lithography to print photonic crystal structures in what was called diffraction coherent lithography.[2] When illuminated with coherent light, the tiled diffractive mask produces images which are 1× replicas at certain locations (Talbot planes). The self-images produced at the Talbot planes are generated by the collective contribution of the diffraction of the thousands of cells in the mask. Because the unit cells (or tiles) are replicated many times in the plane of the mask, any defect in any of the unitary cells is averaged over a very large numbers of tiles consequently rendering a virtually defect-free image.[3, 4] This is a unique characteristic of this photolithographic approach.

Figure 1 summarizes our results printing in the photoresist and transferring to a metallic coated substrate to fabricate a functional structure. Figure 1(a) is a SEM micrograph of the mask showing a large amount of defects. The mask were fabricated with a 180nm thick resist (50% ZEP520A) spun on top of the Si_3N_4 membrane. The membrane was pre-baked at 120 C for 3 minutes and was exposed by e-beam writer Jeol6300 FX that defined the array of unit cells. After the e-beam exposure the resist developed to generate the patterns on resist. The 180nm ZEP520A layer where the mask was defined was used as a sacrificial mask for reactive ion etching (RIE) to etch through the Si_3N_4 membrane. In spite of the large amount of defects in the master self- standing mask, the print obtained is free of defects. Figure 1(b) is a SEM micrograph of the structure transferred to gold using anisotropic ion milling.

The defect-tolerant characteristic of the Talbot lithography was demonstrated as a proof of principle in our former work [4]. Here we show that with this approach it is possible to fabricate a functional surface, transferring the periodic pattern to the metal-coated substrate without errors. The Talbot lithography offers an alternative flexible method for fabrication with sub-micron resolution, allowing generating defined structures even from a heavily damaged master masks.

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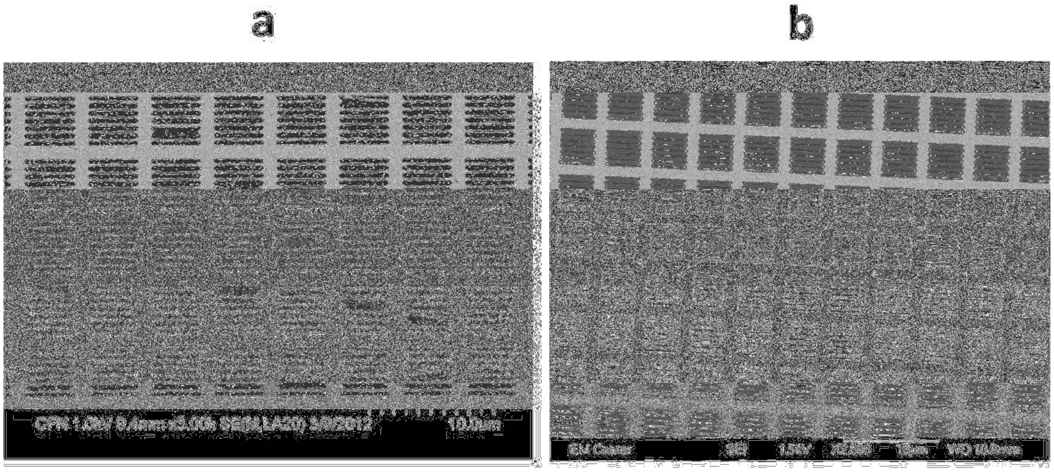

Figure 1. Demonstration of defect-free fabrication of metallic structures using Talbot lithography. a) defective Talbot mask utilized to print a defect-free photoresist pattern that was transferred to a Au layer using ion etching to obtain a defect free metallic structure (b)