λ/12 Sub-wavelength Optical Lithography with a Smooth Superlens

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Recent theory suggested a novel approach of optical imaging and lithography with resolution far beyond the diffraction limit[1]. This can be done simply by exciting surface plasmons of a thin silver film, allowing the recovery of evanescent waves in the near field image. Resolution as high as 60 nanometers or 1/6th of wavelength has been achieved experimentally[2]. This unique optical superlens will enable parallel imaging and nanofabrication in a single snapshot, a feat that is not yet available with other nanoscale techniques such as scanning electron microscopy or e-beam fabrication. In this work, we demonstrate that such image resolution can be further refined to 1/12th of the wavelength through smooth superlens. Applying the state-of-the-art nanoimprint technology and intermediate wetting layer for the growth of silver film, we show that a smooth superlens can be fabricated with thickness down to 15nm. With optimized design of multilayer superlens (working wavelength of 380 nm), our numerical and experimental results both indicate the feasibility of resolving features of 30nm and below. The development of potential low-loss and high resolution superlens opens the door to exciting applications in nanoscale optical metrology and nanomanufacturing.

References:

1. J.B. Pendry, Phys. Rev. Lett. **85**, 3966 (2000).
2. N. Fang, H. Lee, C. Sun and X. Zhang, Science **308**, 534 (2005).

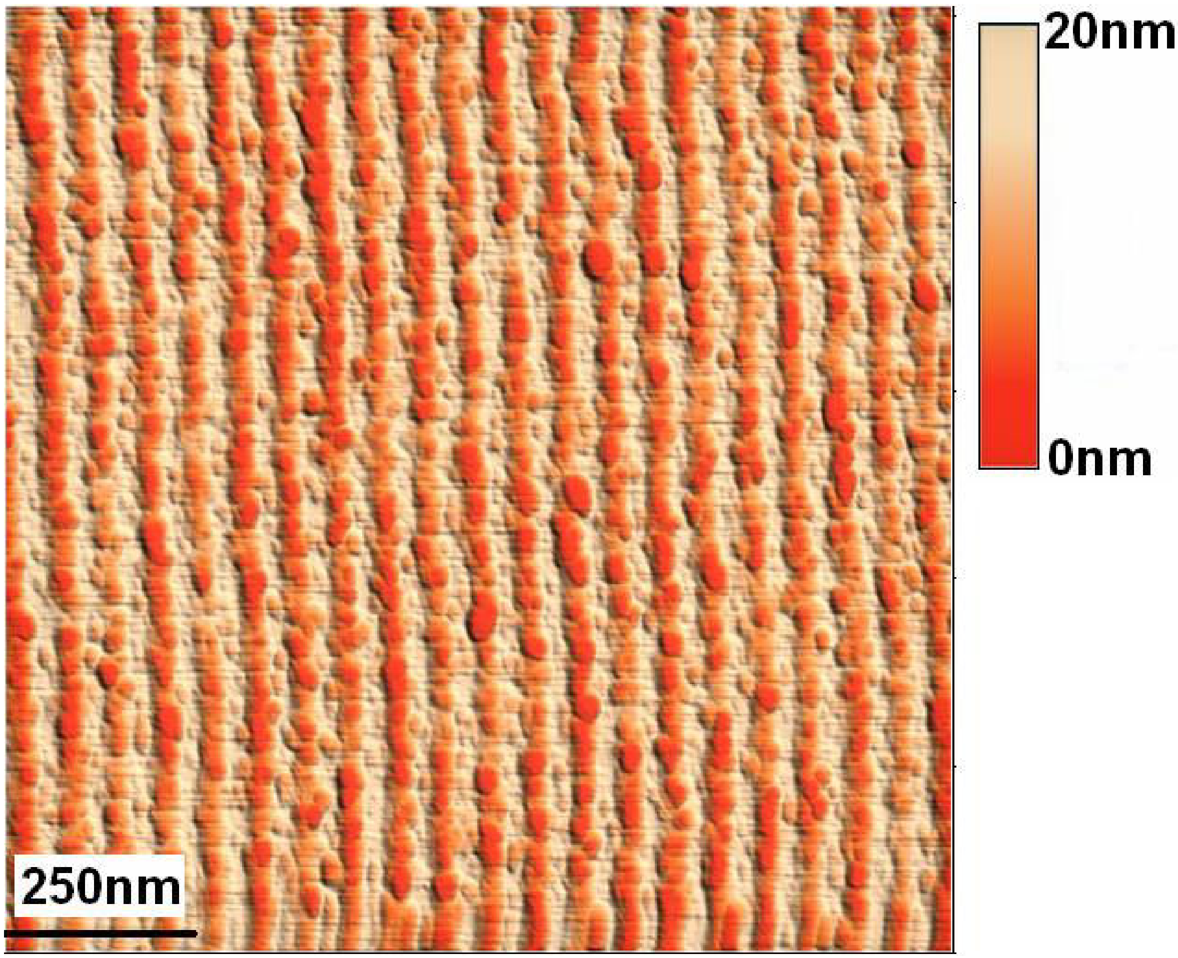

Fig 1: Atomic Force Micrograph of the developed image clearly showing chromium gratings with 30nm half-pitch successfully recorded onto photoresist.