Ag superlens images nano objects

A superlens built out of a thin layer of Ag (silver), which has a negative index of refraction, and can image nanoscale objects has been demonstrated by Nicholas Fang and colleagues at the Univ. of California at Berkeley. The superlens works because it focuses on propagating waves and evanescent waves, which decay rapidly with distance from an object. Evanescent waves carry the sharpest details of an object but cannot be recovered by conventional positive-index lenses, which can resolve objects to no better than approximately one-half of the illuminating wavelength —the diffraction limit. This superlens, however, can image structures with a resolution around one-sixth the wavelength of an illuminating light in the near field.

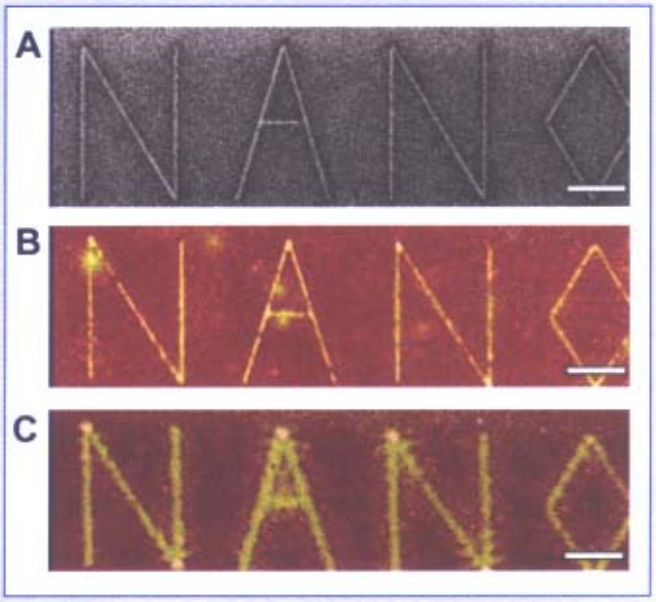

Fig. 1. NANO imaged by Ag superlens. ***A)*** FIB image; linewidth is 40 nm. ***B)*** AFM image on photoresist. ***C)*** AFM image on photoresist when 35-nm thick layer of Ag is replaced by PMMA spacer as control. Lines are wider. *Source:* Science.

In the experiments, a thin film of Ag acts as the superlens that transfers the image of a lithographically written pattern, the word "NANO" to a layer of photoresist. The film's surface is smooth (roughness <1 nm) and its thickness is optimized (~35 nm). If the surface is not smooth, then it will scatter the incident light, washing out the sharp details carried by the evanescent waves. If the material is too thick (above a thickness of 40 nm), then material losses dominate over the evanescent wave refocusing, which destroys the superlensing effect.

The Ag superlens can image arbitrary nanostructures with sub-diffraction-limited resolution. The image NANO (Fig. 1B) shows an excellent reproduction of the fine features from a mask (Fig. 1A) in all directions with good fidelity. Here, the evanescent waves are recovered and the averaged cross section of letter A shows an exposed linewidth of 89 nm. In a controlled experiment performed on the same mask, the word NANO is embedded in 75-nm planarized PMMA using the same exposure condition. With the absence of an Ag superlens (Fig. 1C), the lines that form the letters are diffused with a measured linewidth of >300 nm.

Potential applications include higher-resolution optical imaging and nanolithography. The work is described in the April 22, 2005 issue of *Science.*

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