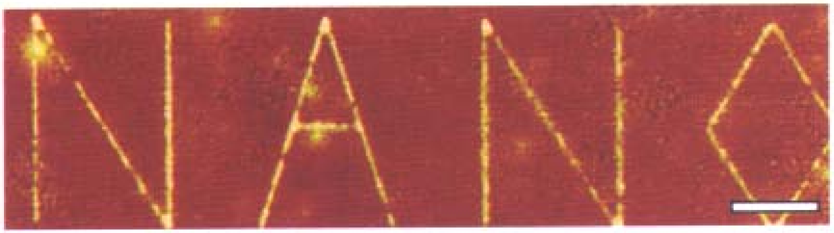
Superlens overcomes diffraction limit

Five years ago, John Pendry at Imperial College, London (U.K.) postulated that the diffraction limit, which restricts the resolution of current optical lenses to ~400 nm, could be overcome with a superlens (*Phys. Rev. Lett.* **2000**, *85*, 3966–3969). Now, Xiang Zhang and colleagues at the University of California, Berkeley, have confirmed Pendry's prediction by creating a superlens with a resolution of ~60 nm.

Pendry's superlens theory stemmed from an idea proposed by Victor Veselago in 1968 about materials with a negative index of refraction. The electromagnetic field of an object has both propagating waves and near-field evanescent waves. The evanescent waves, which contain fine details about the object, decay exponentially as the distance from the object increases. Unfortunately, conventional lenses with a positive refractive index can't capture these waves. Pendry suggested that a planar layer of a material with a negative refractive index should be able to refocus the evanescent waves and produce an image with sub-diffraction-limit resolution.


An AFM image of features etched onto a photoresist by evanescent waves focused by a silver superlens. Scale bar = 2 μm. (Adapted with permission. Copyright 2005 American Association for the Advancement of Science.)

Zhang and colleagues experimentally demonstrated Veselago and Pendry's predictions with a 35-nm planar layer of silver that had a negative refractive index. Light of 365-nm wavelength illuminated a 50-nm chromium mask. The mask was etched with features that had dimensions <365 nm.

The silver focused evanescent waves emanating from the mask's features onto a layer of photoresist. The etched features were then traced with an atomic force microscope (AFM) to produce an image.

The investigators patterned the word "NANO" into a chromium mask. Without the layer of silver in place, the resulting lines in the photoresist were >300 nm in width. When the superlens was present, the line widths in the image were <90 nm. (*Science* **2005**, *308*, 534–537)