Superresolution in lossy metamaterials

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The absorption loss deteriorates the ideal image reconstruction in the near-field superlens(NFSL). Due to this unavoidable loss problem in metal layer of NFSL, the achievable superresolution significantly decreases.[1] This loss problems are more critical in longer wavelength region, such as infrared and THz regime. We calculate the superresolution of NFSL with the image visibility of an imaging system of a double slit with the specified slit width and peak-to-peak separation, as shown in Fig. 1.[2-5] We exemplify the infrared NFSL with TiO2 and SiO2 because superlensing effect is not observed because the absorption loss is significant.[5] The permittivities of TiO2 and SiO2 depending on wavelength are shown in Fig. 2(a). The visibilities (V) of transmission field through the double slit are shown in (b) in slit width and peak-to-peak separation plane for the conventional index match case. We optimized the phase transfer function of optical transfer function to get the highest visibility for each specified geometry, and achieved enhanced superresolution as shown in (c). The correspondingly optimized wavelength of incident light is plotted in (d).

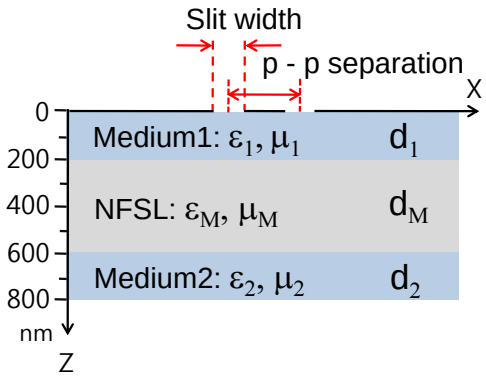

Fig. 1. Schematics of a near-field superlens.

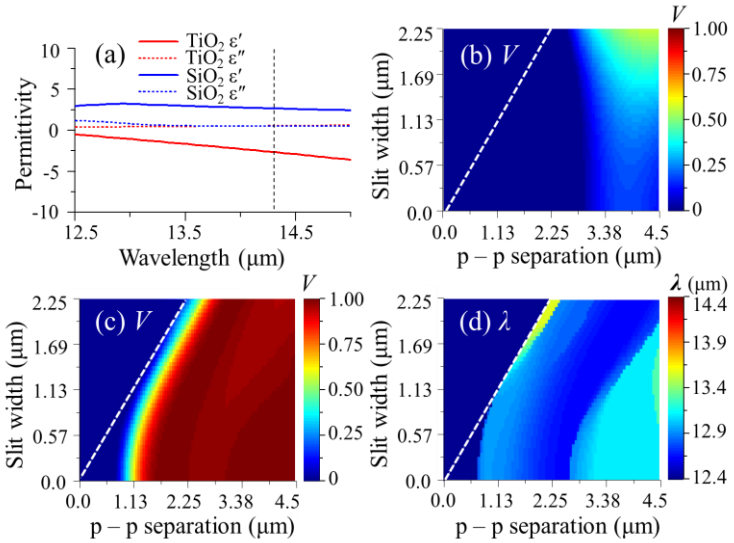

Fig. 2. Enhaced superresolution of a TiO2 near-field superlens using phase-correction method. (a) Dispersion relation of TiO2 and SiO2. (b) Visibility versus peak-to-peak separation and slit width for a double slit for the conventional case. (c) The enhanced visibility using phase retrieval method. (d) The corresponding wavelength for the optimized visibility in (c).

References

1. J. B. Pendry, "Negative refraction makes a perfect lens," Phys. Rev. Lett. 85, 3966–3969 (2000).

2. K. Lee, H. Park, J. Kim, G. Kang, and K. Kim, "Improved image quality of a Ag slab near-field superlens with intrinsic loss of absorption," Opt. Express 16, 1711–1718 (2008),

3. K. Lee, Y. Jung, G. Kang, H. Park, and K. Kim, "Active phase control of a Ag near-field superlens via the index mismatch approach," Appl. Phys. Lett. 94, 101113 (2009).

4. K. Lee, Y. Jung, and K. Kim, "Near-field phase correction for superresolution enhancement," Phys. Rev. B 80, 033109 (2009).

5. K. Lee, Y. Jung, W.J. Padilla, and K. Kim, "Elimination of phase singularity to achieve superresolution in lossy metamaterials," Opt. Express 18, 12269 (2010).