Beaming Light from a Subwavelength Aperture - Diffraction Control and Enhanced Transmission -

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Materials structured on the nanometer scale can lead to improved and sometimes surprising properties. This will be illustrated in some detail by our own work on the extraordinary optical properties acquired by metal films when periodically structured and perforated with one or more subwavelength holes ($\sim$150 nm). These can transmit light with an efficiency hundred times larger than what theory predicts for single holes. The efficiency can even be much larger than the fractional area occupied by the hole, which means that even the light falling beside the hole emerges on the other side of the sample. This extraordinary transmission is due to the coupling of the incident light with the surface plasmons of the film. The transmission spectrum contains peaks attributed to surface-plasmon modes that depend on both the symmetry and the 2D lattice parameter of the surface corrugation. Present models for the actual transmission process will be discussed. Novel results show that an other fundamental problem of sub-wavelength apertures, namely optical diffraction, can also be controlled using surface plasmons.

The results have broad fundamental and practical implications and show that, with modern fabrication techniques, surface plasmons can be engineered and controlled to yield unique optical properties which could find application in high density data storage, photonic integration, near field probes, etc..

Ref.: Ebbesen et al Nature 391, 667 (1998); Ghaemi et al, Phys. Rev. B 58, 6779 (1998); Grupp et al Adv. Mater. 11, 860 (1999); Kim et al, Optics Letters 24, 256 (1999); Grupp et al, Appl. Phys. Lett., 77, 1569 (2000); Martin-Moreno et al, Phys. Rev. Let.. 86, 1114 (2001); Krishnan et al. Optics Comm. 200, 1 (2001); Lezec et al, Science 197, 820 (2002).