Metamaterials in the extraordinary optical transmission

Namkyoo Park[1,*], Sukmo Koo[1], and Daisik Kim[2]

[1]*Photonic Systems Lab., School of EECS, Seoul National Univ., Seoul, Korea, 151-744*

[2]*Center for Subwavelength Optics, Dept. of Physics, Seoul National Univ., Seoul, Korea*

**E-mail:nkpark@snu.ac.kr*

Utilizing nano-metallic structures for the extra-ordinary strength focusing of Electromagnetic waves offers an unexplored path to break the classical limit of light diffraction and related applications. Employing metallic nano-slit [1] or nano-wires [2], or by modifying the structures of metallic nano-structures [3], it becomes possible to extra-ordinary enhance electric or magnetic field selectively, to be used in novel applications such as spatial modulators [4] or ultra-high index materials [5].

In this presentation, we review the physics behind the extra-ordinary super-focusing effect, and will address some of the application examples including THz thin film spatial modulator [4], and high index meta-materials [5]. Obstacles in the future extension of the EOT technique, such as the issue of lambda-zone [6] and metallic loss will be addressed, with some preliminary examples of possible solutions for the given problem - adopting meta-material for the extra ordinary superfocusing of electromagnetic field.

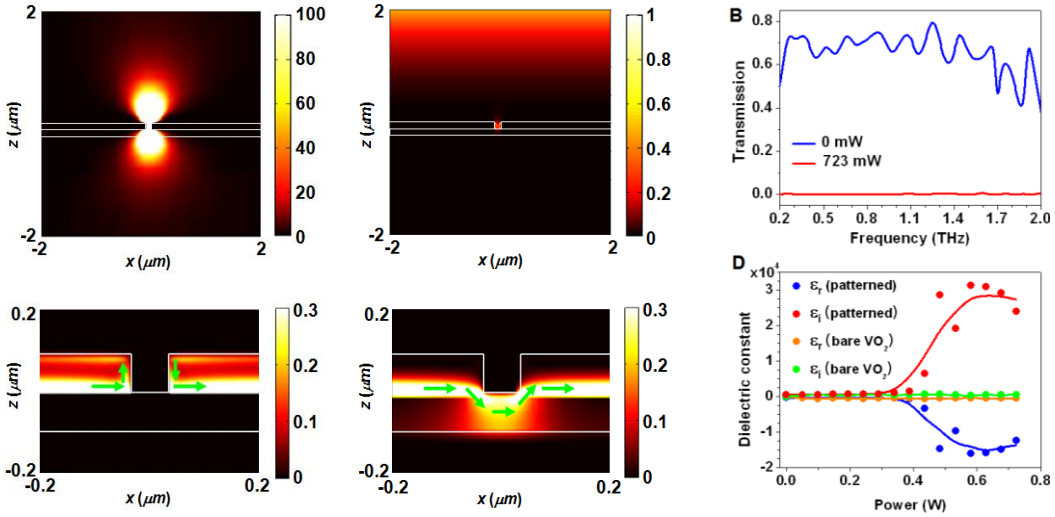

Figure 1: Nano-antenna MM THz modulator. left: On state, right: Off state. (B) Transmittances of a broadband active MM at the frequency of 0.2-2.0 THz for 0 mW (blue lines) and 723 mW (red lines) excitation power of a cw 532 nm laser. (D) Dielectric constants (0.6 THz) for the broadband MM as a function of excitation power, compared to bare VO2 film.

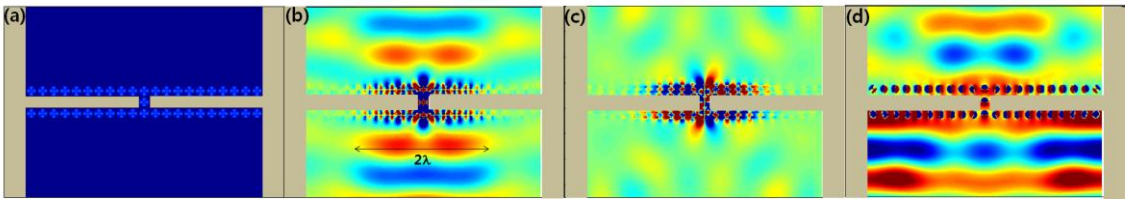

Fig. 2. The structure / field pattern of the extra ordinary transmission through the meta-material layered subwavelength slit. Gray regions are assumed to be a PEC. (a) The structure, (b) $\boldsymbol{E}_x$, (c) $\boldsymbol{E}_y$ and (d) $\boldsymbol{H}_z$ field obtained from the FDTD.

The MM region consists of 21 particles per layer (4.2λ). The width of the slit is 0.21λ. About 2λ (50%) of the plane wave transmit through the slit, exceeding the limitation imposed by the lambda zone.

References

1. Seo, M.A., Park, H.R. et. al., *Nature Photonics*. 3, n3: pp 152-156 (2009).
2. Koo, S., Kumar, S.M. et. al., *Phys. Rev. Lett*. 103: pp 263901 (2009).
3. Sadiq, D., Shirdel, J. et. al., *Nano Letters*. 11: pp 1609-1613 (2011).
4. Seo, M.A., Kyoung, J. et. al., *Nano Letters*. 10: pp 2064-2068 (2010).
5. Choi, M., Lee, S. H., et. al., *Nature*. 470: pp 369-373 (2011).
6. Kang, J.H., Kim, D.S., Park, Q. H., *Phys. Rev. Lett*. 102: pp 093906 (2009)