THz single annular aperture antenna for highly-sensitive sensing

Teun-Teun Kim

Center for Integrated Nanostructure Physics (CINAP), Institute for Basic Science (IBS), Suwon 16419, Republic of Korea

Extraordinary optical transmission (EOT) is a well-known phenomenon of the greatly enhanced transmission of light through a subwavelength aperture in a metal film, which has been patterned with a regularly repeating periodic structure [1]. EOT effect has been widely utilized for optical sensing and spectroscopy applications from visible to THz regimes [2,3]. However, the conventional EOT effect can be measured through wafer-scale periodic arrays to increase the signal-to-noise ratio for detection due to the diffraction limit. Here, we experimentally demonstrated a single annular aperture as a practical platform for THz absorption spectroscopy. THz tip-probe near-field measurement system is used to investigate the electric field distribution in a single annular aperture and near-field image clearly shows that the electric field is strongly confined at the gap. Near-Field transmissions at the gap as a function of the distance of the THz probe from the sample also show that the field enhancement inside the gap dramatically increases. After inserting lactose in the gap, we can couple the intense optical fields of the single annular gap into the vibrational modes of lactose molecules. We observed high contrast THz absorbance signals drastically suppressing of the transmitted light. This result indicates that the single annular aperture can be used as a platform that is promising avenues toward future drastic miniaturization of THz devices and sensors.

References

[1] T. W. Ebbessen et al. Nature, 391, 6668 (1998).
[2] H. -R. Park et al. ACS Photonics, 2, 417-424 (2015)
[3] M. Seo et al. Advanced Optical Materials, 1900662, (2019)