Non-Hermitian Metasurfaces for Sensitive Optical Systems

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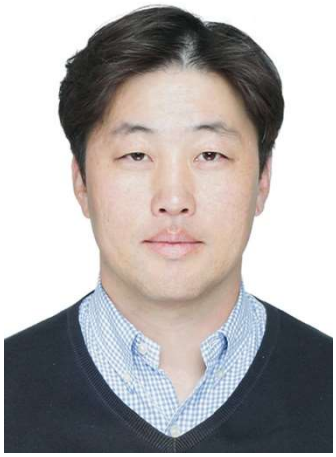
Abstract: We present the observation of chiral exceptional points and phase singularities within a non-Hermitian metasurface [1-3]. By designing a metasurface with hybrid meta-atoms characterized by anisotropic radiation loss and utilizing graphene to adjust the intrinsic coupling among meta-atom components, we successfully controlled polarization eigenstates by altering the radiation frequency and graphene's optical conductivity. This research uncovers a polarization phase singularity at the exceptional point during transmission through an anisotropic metasurface. Furthermore, by combining this system with microfluidic channels, we enabled the detection of trace amounts of conductive biochemical samples. Our metasurface framework offers an essential platform for investigating dynamic phenomena with non-Hermitian chiral degeneracies and could enable the development of innovative polarization-based devices and highly sensitive sensors.

References:

1. S. H. Park, et al., "Observation of an exceptional point in a non-Hermitian metasurface" *Nanophotonics* **2020**, 9, 1031–1039.
2. S. Baek, et al. "Non-Hermitian chiral degeneracy of gated graphene metasurfaces" *Light Sci Appl* **2023** 2, 87.
3. D. Oh, et al. "Complete asymmetric polarization conversion at zero-eigenvalue exceptional points of non-Hermitian metasurfaces Nanophotonics" *Nanophotonics* **2024** 13, 4409-4416.



Prof. Teun-Teun Kim is an assistant professor in Department of Semiconductor Physics & Engineering. He received Ph.D. in physics from the KAIST in 2010. From September 2010 to August 2013, he was a Post-Doctoral Research Fellow at KAIST, and from September 2013 to February 2017, he worked as the Marie Curie Fellow in the Metamaterial Research Centre at University of Birmingham, UK. In March 2017, he was awarded, IBS Young Scientist Fellowship in IBS, CINAP at Sungkyunkwan University. His current research focuses on photonic devices and bio-sensors with metamaterials and plasmonics at THz regime, and 2D materials photonics including graphene and transitionmetal dichalcogenide. Since 2007, he has published a total of 44 peer-reviewed research papers, including 10 as the first author and 14 as the corresponding author. Notably, his work has been published in prestigious journals such as Nature Materials, Nature Communications, and Science Advances.