物質科学セミナー
2024 年 4 月 2 日（火）午後 3 時–
3B213 プレゼンテーションルーム

# DNA origami-assisted unidirectional meta-emitters based on Kerker condition

Jer-Shing Huang

a. Leibniz Institute of Photonic Technology, Albert-Einstein-Str. 9, 07745 Jena, Germany
b. Institute of Physical Chemistry and Abbe Center of Photonics, Friedrich-Schiller-Universität Jena, D-07743 Jena, Germany.
c. Research Center for Applied Sciences, Academia Sinica, Taipei 11529, Taiwan.
d. Department of Electrophysics, National Yang Ming Chiao Tung University, Hsinchu 30010, Taiwan.

Email: jer-shing.huang@leibniz-ipht.de

Confining the emission of single quantum emitters into a pre-defined direction is of great interest for the applications of single-photon sources. Plasmonic nanoantennas enable the control and manipulation of radiation from single quantum emitters. Previously, we demonstrated top-down fabricated broadband unidirectional transmitting optical nanoantennas based on the interference of coherent waves from multiple resonators [1]. However, the performance depends on the number of resonating elements, making the top-down fabricated unidirectional nanoantennas bulky. Recently, DNA origami technology has been used to assemble nanoparticles. In this talk, I will present our recent work on ultracompact DNA origami-assisted unidirectional nanoantennas (footprint ~ 150 nm) based on Kerker condition [2], i.e., the balanced interference of the induced electric (ED) and magnetic dipole (MD) in the same structure (Fig. 1a). The meta-emitter consists of three gold nanoparticles and a single dye molecule (Atto647N) on a precisely engineered DNA origami template. To bring the emitter to the center of the gap, the DNA origami was designed to capture one of the three gold nanospheres (diameter = ~70 nm) on the opposite side of the triangular origami template (Fig. 1b). Trimer nanoantennas were obtained at high yield (Fig. 1c) and the emission of the single dye molecule show clear unidirectionality. The largest front-to-back emission ratio (F/B) was found to be more than 10 dB (Fig.1d). I will also present our finding that intensive and polarized laser illumination can turn DNA molecules into carbon-based emitters with superior brightness [3]. This may offer a convenient way to create nanoscale emitters at arbitrarily chosen locations.

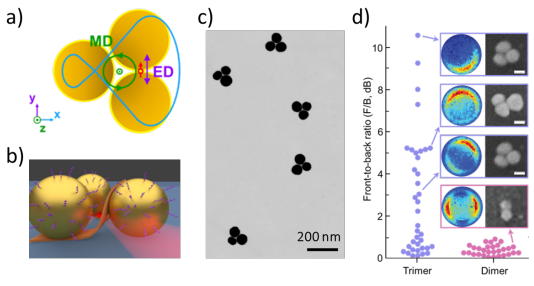


**Figure 1.** a) Configuration of the trimer nanoantenna driven by a single emitter (red arrow). The unidirectional radiation pattern (blue contour) stems from the balanced interference of the electric dipole (ED) and magnetic dipole (MD). b) A schematic showing how the curved origami template brings the single emitter to the dimer gap. c) An SEM image of the DNA origami-assisted trimer nanoantennas. d) Representative emission patterns and SEM images of trimer and dimer antennas. Distinct directionality (F/B ratio in dB) is found between trimers (purple dots) and dimers (pink dots).

References

[1] "Photoluminescence-Driven Broadband Transmitting Directional Optical Nanoantennas" See, K.-M.; Lin,

F.-C.; Chen, T.-Y.; Huang, Y.-X.; Huang, C.-H.; Yeşilyurt, A. T. M.; Huang, J.-S. *Nano Lett.* **2018**, *18*, 6002-6008.
[2] "Unidirectional Meta-Emitters Based on the Kerker Condition Assembled by DNA Origami" Yeşilyurt, A. T. M.; Sanz-Paz, M; Zhu, F.; Wu, X.; Sunil, K. S.; Acuna, G. P.; Huang, J.-S. *ACS Nano*, **2023**, *17*, 19189-19196.
[3] "Nanoscale Hotspot-Induced Emitters in DNA-Assisted Nanoantennas" Yeşilyurt, A. T. M.; Wu, X.; Tapio, K; Bald, I.; Huang, J.-S. *J. Am. Chem. Soc.*, **2023**, *145*, 25928–25932.

**共催**
TREMS