Characterization and design optimization technologies of metasurface reflectors for terahertz communications

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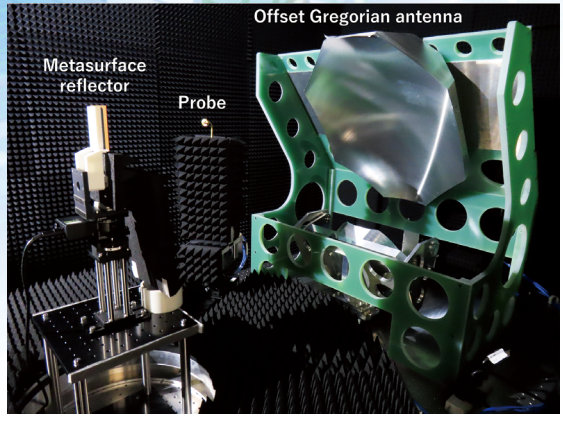
In next-generation 6G communications, terahertz waves are expected to enable ultra-high-speed and large-capacity wireless communications. Metasurface reflectors, which efficiently redirect incident waves into specified directions, have attracted significant attention for coverage expansion. However, in the terahertz band, the reflector size becomes extremely large relative to the wavelength, making accurate performance characterization under plane-wave illumination, equivalent to practical use conditions, particularly challenging.

To address this issue, we developed a compact reflector characterization system based on a compact antenna test range (CATR) with an offset Gregorian antenna. This system generates a quasi-plane wave and enables precise far-field characterization of metasurface reflectors within a compact setup. Using this approach, we fabricated and characterized a dual-band metasurface reflector operating at 220 GHz and 293 GHz. The measured results confirmed strong anomalous reflections in the designed direction, demonstrating reflection characteristics consistent with the simulations and validating the effectiveness of the characterization system.



Photograph of the developed characterization system for the metasurface reflector

Furthermore, we are addressing the explosive growth of design freedom for large-area metasurfaces by developing efficient optimization frameworks using quantum and quantum-inspired annealing. These foundational technologies are expected to accelerate the advancement and practical deployment of metasurface reflector technologies for terahertz communications.

Reference:
[1] Y. Kato, M. Ameya, M. Tezuka, H. Kobuke and A. Sanada, "220/293 GHz Dual-Band Anomalous Reflectors Using Higher-Order Diffraction Modes and Their Precise Characterization Using a Compact Antenna Test Range System," *IEEE Access*, **vol. 11**, pp. 139295-139305, 2023.
https://ieeexplore.ieee.org/document/10348588

[2] Y. Kato, M. Ameya, R. Shimasaki and A. Sanada, "Beam Forming Design of Anomalously Reflective Metasurface Based on Quantum Annealing," 2025 19th European Conference on Antennas and Propagation (EuCAP), Stockholm, Sweden, 2025, pp. 1-4.