Optically Transparent Reflectarray Antenna (RAA) for Future Self-Powered Communication Systems

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In recent years, there has been growing interest in transparent antennas that can offer spatial extensibility and more usable area than traditional opaque ones, especially in the era of 5G and beyond. These transparent antennas can be flawlessly integrated with solar panels, displays, lighting devices, and window glasses to enable the vision of ubiquitous connectivity. In particular, the compact transparent antennas integrated with photovoltaic cells have emerged as a promising solution for 5G ecosystems driven by solar powers. In this talk, we will present optically-transparent X-band reflectarray antenna (OTRA) and optically-transparent radomes (OTRD), which can have an averaged transmittivity of \(~90\%\) in the visible light spectrum and enhance the realized gain of the feed source by more than 10 dB. The proposed OTRA and OTRD are based on bilayer metasurface structures integrated with a grounded solar panel and can be fully modeled with analytical formulation. We have designed, optimized, fabricated and fully characterized the OTRA and OTRD. Their radiation and scattering properties, including physical bounds on the maximum gain, insertion loss, and blockage, will be discussed. Specifically, we will discuss the necessary compromise between the optical transparency (which is related to solar panel’s photovoltaic efficiency) and radio-frequency (RF) properties, such as maximum gain enhancement, phase errors and loss. In addition, we will study the reconfigurable OTRA and OTRD enabled by FPGA-controlled unseeable electronic switches. The reconfigurable OTRA and OTRD with wide angle-tuning range and beamshaping capability show great potential for making the intelligent reflective surfaces (IRS), of interest for 6G communication systems. We envision that the proposed transparent devices with beamshaping functions and electronically reconfigurable patterns (potentially solar-driven) may be beneficial for the next-generation communication and radar applications.