Metasurface Antennas and Packaging at Terahertz Frequencies

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Packaging of terahertz instruments is very challenging, as it requires high precision and good tolerances. It gets even more difficult at terahertz frequencies to integrate the instrument system with antennas. Commonly used antennas such as microstrip, patches, and others are generally not preferred due to their high losses. It is common knowledge that losses of traditional transmission lines increases substantially as the frequency approaches the terahertz band. This proves to be a bottleneck in coupling the antenna output to the rest of the system as the optimization of performance, loss, and reflections become too demanding. To overcome these shortcomings, alternative technologies such as planar metasurface antennas, lens based leaky-wave antennas, and silicon micromachined based antennas and coupling structures are increasingly getting more attention of late.

In recent years, people have made progress in developing ultra-light, efficient, low profile, and high gain antennas that can be integrated with the rest of the instruments with low-loss packaging. One of the advantages of these antennas is that they do not require any external reflectors and associated structures. These new class of planar antennas has textured surfaces, also known as metasurface, on a thin support and can provide high directivity, low-loss, and high efficiency. In comparison with reflectarray antennas, which also has low profile, the metasurface antennas have the feed in the aperture plane, eliminating the need of external feeds.

In this paper, we will present an all-metal metasurface-based planar low-profile antenna working in the 300 GHz band. Fig. 1 (left) shows this antenna integrated on the outside wall of a CubeSat, providing high directivity without any deployable mechanism. The 300 GHz all-metal antenna consists of an array of metallic cylinders on a ground plane, resembling a Fakir's bed of nails, arranged in a periodic square lattice. The prototype 8-mm diameter antenna uses 30-µm diameter metal pins whose heights varying from 150-µm to 175-µm, separated by 140-µm. Simulated gain of the antenna is better than 20 dB with low cross-polar performance. Fig. 1 (center) shows the SEM picture of the silicon micromachined fabricated antenna and Fig. 1 (right) shows the picture of the assembled antenna after metallization. We will present measured results.

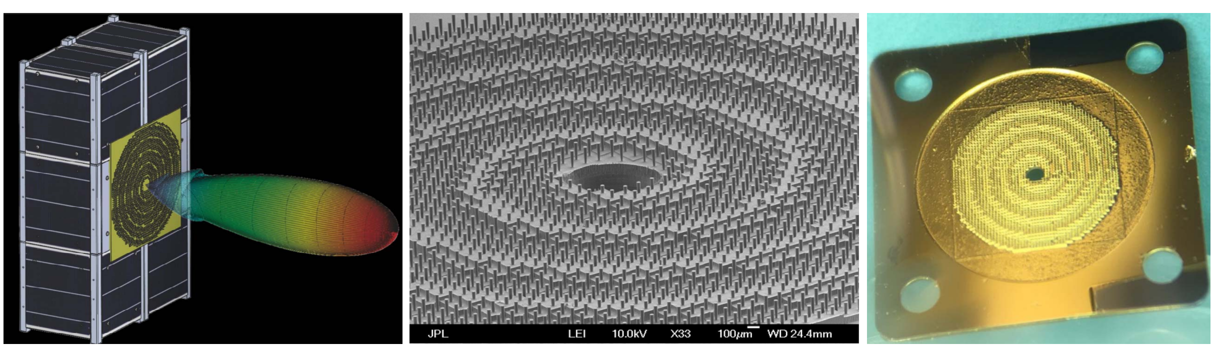

Figure 1. Fig. 1: Schematic of a low-profile metasurface Fakir-Bed antenna integrated on the sidewalls of a CubeSat (left). SEM picture of a 300 GHz metal pin based Fakir-Bed antenna (before gold plating) fabricated with silicon micromachined technology (center). Picture of the assembled low-profile antenna (right).