Silicon Image Guide (SIG) Coupled Resonators Antenna for Millimeter-wave/THz Applications

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Recently dielectric antennas have gained a huge interest in millimeter-wave (mmWave) and THz range of frequencies for a wide range of applications such as wireless communication, imaging, and radioastronomy. The most common type of dielectric antenna is the tapered antenna, which is inherently long and radiates in the end-fire direction. To realize a down-sized antenna for radiating in a tilted angle, the idea of dielectric resonator in the configuration of dielectric waveguide antennas can be utilized.

The proposed antenna, shown in Fig.1(a), is implemented in the Silicon Image Guide (SIG) technology made of High Resistivity Silicon (HRS) and operating over 164-166 GHz. The SIG technology makes the antenna highly-efficient, low-cost, and integratable. The antenna consists of a silicon straight waveguide segment connected to a series of disc resonators, acting as radiating elements. The resonators are coupled to each other by narrow support segments. The antenna is tapered at the input for providing a smooth transition to a metallic waveguide for measurement. The straight waveguide is designed to support a highly confined single mode field. The optimum number of the resonators is four, for which a reasonable gain is achieved while the side-lobe levels are minimized. The disc resonators are contributing to the radiation in two ways: 1) radiation by the resonance mode, and 2) radiation due to geometrical changes and discontinuities. The antenna is fabricated using the in-house developed laser machining technique which is a chemical free, fast, and mask-free fabrication procedure (refer to Fig.1(b)). The coupled resonators antenna is designed and optimized using the HFSS full-wave simulator and the simulated gain patterns over 164-166 GHz are shown in Fig.1(a). The maximum simulated gain is 11.9 dBi for the radiating length of L=3.16 mm (refer to Fig.1(a)). The antenna efficiency is better than 95% with the side-lobe levels and the return loss better than 9 dB and 10 dB, respectively.

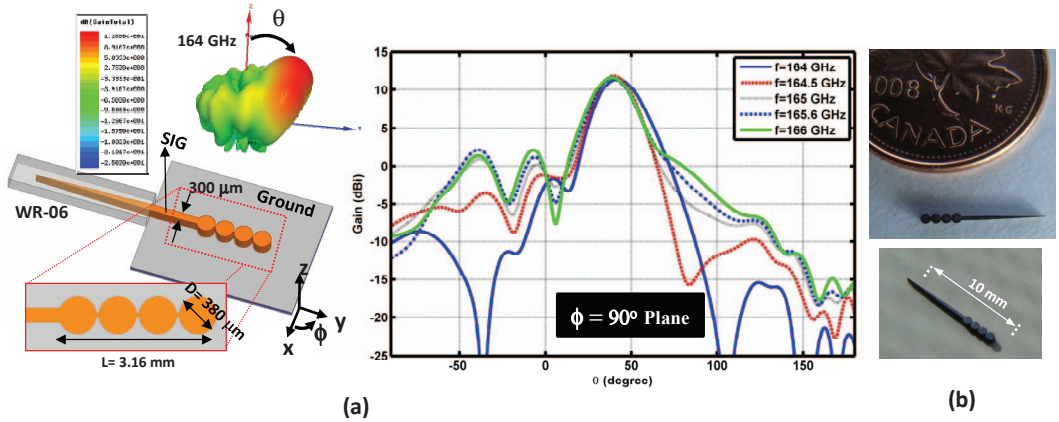

Fig. 1. a) The proposed coupled resonators antenna along with the gain patterns over 164-166 GHz. b) The laser fabricated antenna.