Ring Slot-based Antenna Design for mmWave Integrated OAM Wave Excitations

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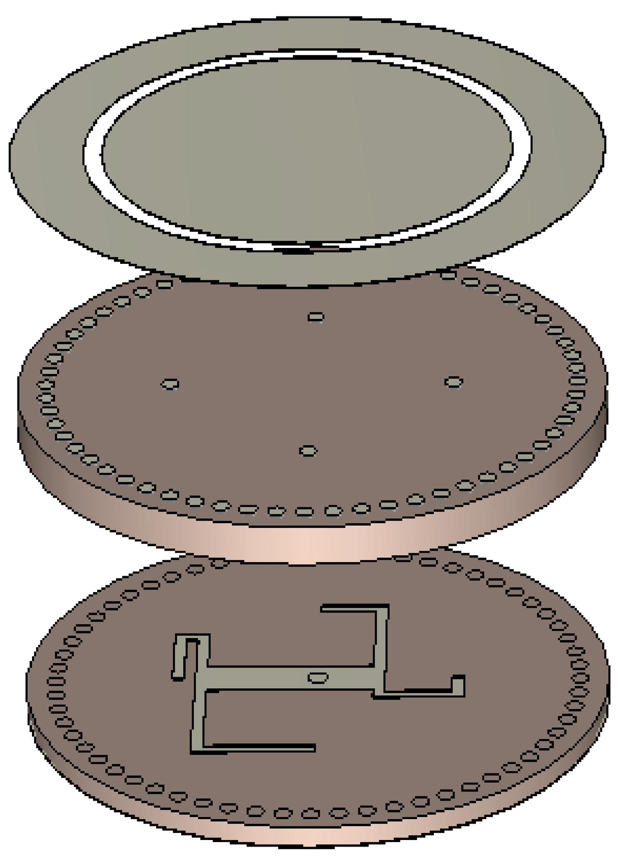
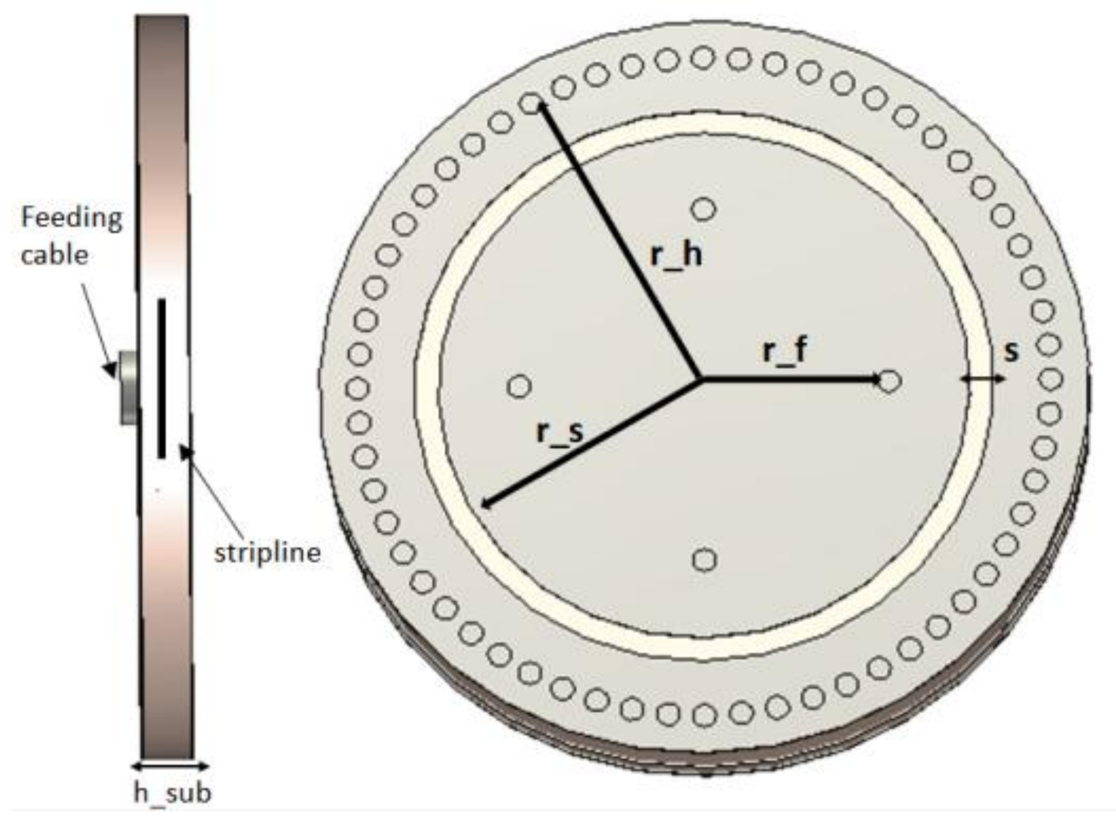
Abstract： In this paper, a ring slot antenna modified by the substrate integrated resonator is proposed for OAM wave excitation at mmWave band. The strip line is employed as a power divider to generate four feeding points with *π/2* phase delays. Changing the ring design parameters can help to adjust the surface current distribution, and further excite the OAM waves with different modes. This antenna topology has the advantages of a low profile, easy for integration and tuning of radiation modes, as well as a maximal radiation gain of 8.5 dBi at 26.0 GHz.

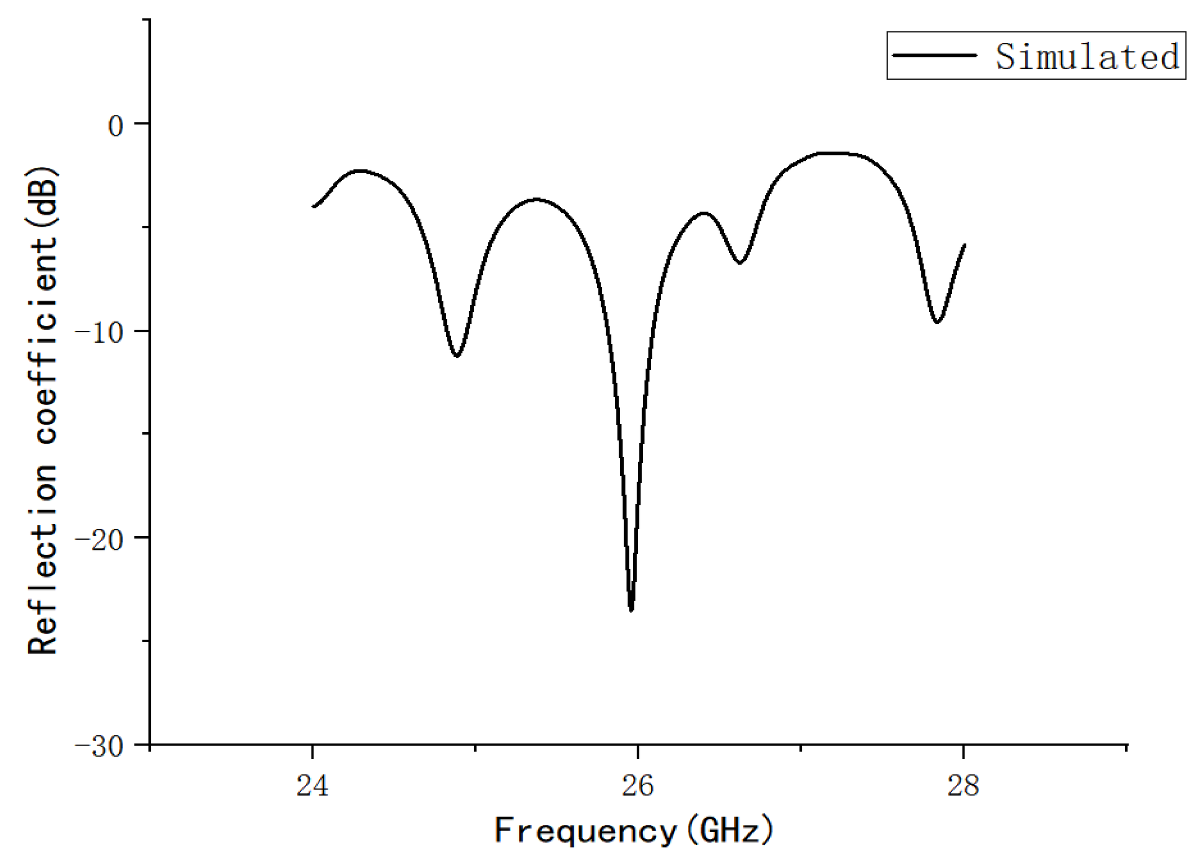
3-D configuration of the antenna



Top and side views of the antenna structure

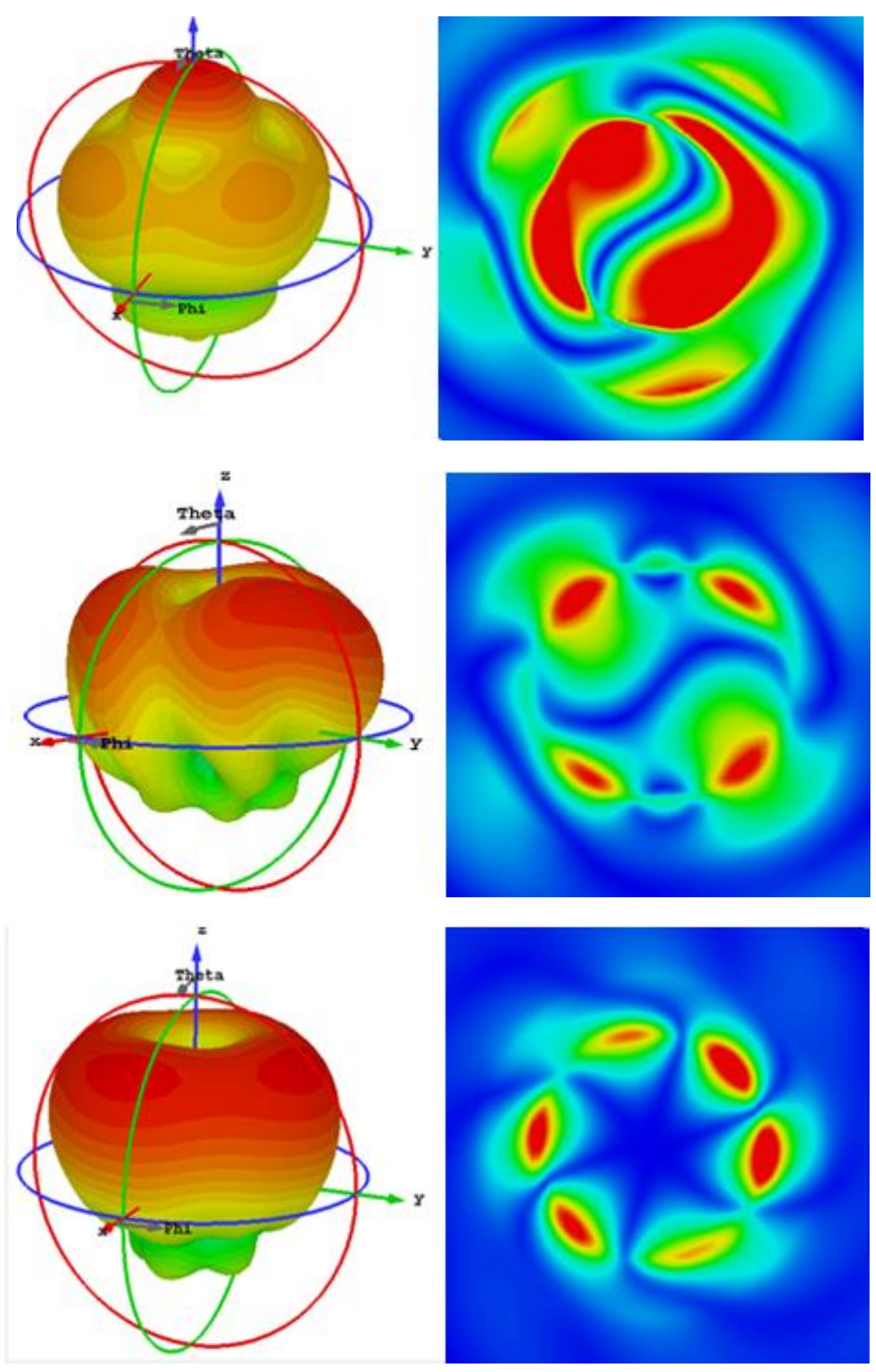


Simulated reflections of the antenna

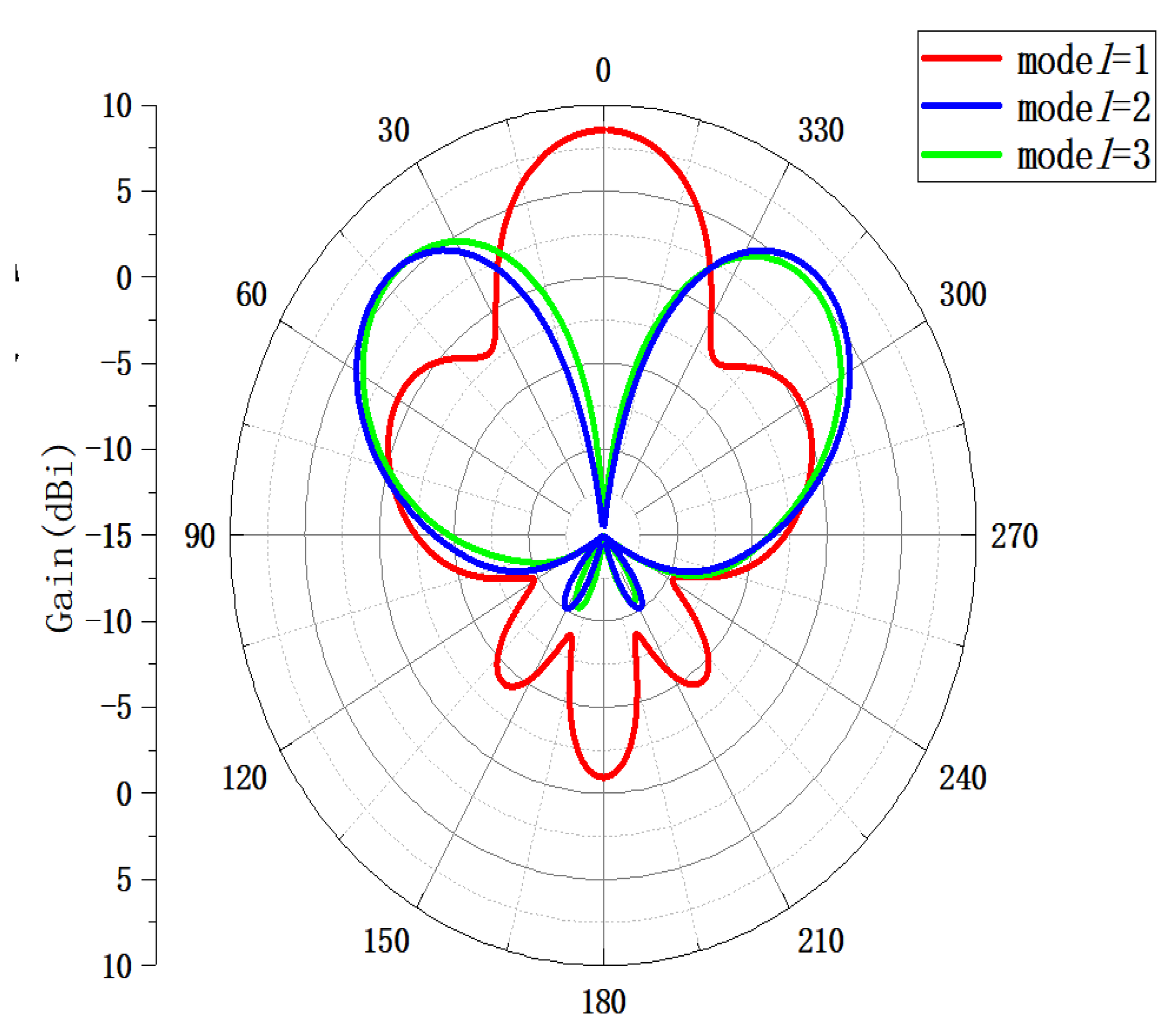


The top side is the ring slot fed by four metal vias. These metal vias are connected with strip lines in the middle layer. The lengths of the strips are reduced a quarter of wavelength in turns to achieve a phase delay for the feeding points. Then, the excited TE mode inside the waveguide will be rotated by the slot and radiated to the space. Changing on the slot design parameters will influence the surface current distributions and help to tune the radiated OAM mode. In total, the complete structure is designed with a radius of 10.0 mm.

Far field radiation pattern with mode *l* = 1、2、3



Far field gain pattern of the antenna with different modes



Figs show the far field radiation pattern and the electric field distributions at *z* direction with different modes. As seen, the radiation mode and electric field distribution will be tuned by the radius of the circular patch and the slot size.Since the radiations generated by the slot is modulated by the rotated wave inside the waveguide. Reduce on the radius of the circular patch will shorten the sectional dimensions for modal field distributions, and thus leading to that the generated OAM mode decreases from high orders to the lower ones.

The radiation pattern shows a middle hollow area which corresponds to the typical OAM mode field distribution. It can be also seen that the hollow area is increasing with mode orders, which is not benefit for the directional transmission of the OAM wave. Some ripples appears possibly because of the perturbations from inside metal vias and strips. The maximal realized gain can be observed with 8.5 dBi when l = 1 with a good strong bonded beam directions.

Conclusion

In this paper, a slot-based OAM wave excitation structure is proposed at the working frequency of 26.0 GHz. Radiations are generated by etching a ring slot on the SIW resonator, and the radiation modes can be tuned by changing the design dimensions of the circular patch and ring slot. This antenna topology has a low profile and easy for the integration applications. Simulation results show that this antenna topology can generate the far field radiations with a relative small middle hollow area and a gain of 8.5 dBi at lower mode, which is much more suitable for directional transmissions of OAM wave over a long distance.

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