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Design of Wideband Planar Transmissive Metasurface Based on Low-Cost PCB Technology

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INTRODUCTION & AIM

High-gain antennas play an important role in long-range wireless communication systems like radar, satellite communication, and space exploration. In such applications, Microstrip array antennas and phased array antennas require complicated feeding networks to realize beamforming and directional radiation, which increases the complexity of antenna design as well as the cost. In contrast, reflective metasurface and transmissive metasurface have high gain property with low cost due to easy fabrication. Compared with reflective, transmissive metasurface offers several advantages such as no aperture blockage from the feed source and less sensitivity to fabricating tolerances . And planar transmissive metasurface shows miniaturized size and lighter weight than traditional 3D lens antennas .

METHOD

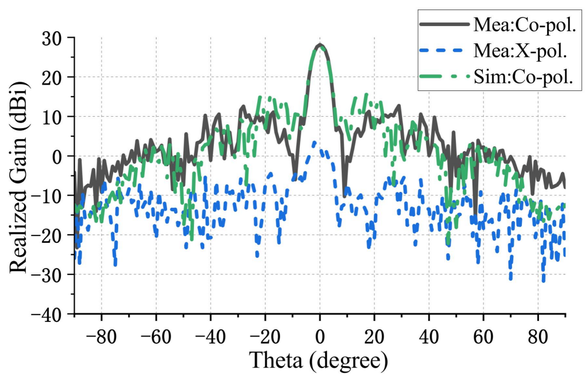
The planar transmission array consists of multiple components Composed of elements with phase shift capability, and the elements are periodically arranged in a transmission array that can be able to achieve beam focusing through appropriate phase compensation, the phases of elements are required to manage the value of phase compensation. And each element on the array has a fixed phase shift value, and the phase shift distribution of each element is pixelated. The phase shift capability of each unit can be controlled by adjusting its structural size, resulting in different phase differences. As can be seen from the above it is feasible that by reasonably distributing the positions of each element and performing appropriate phase compensation on the surface, the spherical electromagnetic waves transmitted to the transmission array are converted into planar electromagnetic waves on the aperture plane, thereby enabling the planar transmission array antenna to achieve beam focusing in the specified direction.The design parameters and simulated transmission performance of the proposed components are shown in the following table.

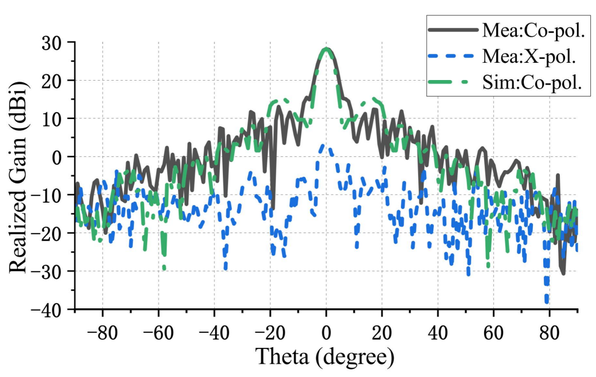
	Unit 1	Unit 2	Unit 3	Unit 4	Unit 5
a	11.6	11.2	10.4	9.8	9.2
b	10.4	11.0	10.6	11.6	11.4
PS	1.03	19.51	40.44	64.51	84.17
IL	-0.054	-0.111	-0.240	-0.326	-0.245
	Unit 6	**Unit 7**	**Unit 8**	**Unit 9**	**Unit 10**
a	8.8	8.4	8.0	7.6	7.4
b	11.6	11.6	10.6	9.4	10.0
PS	100.24	122.96	141.12	158.33	179.33
IL	-0.122	-0.078	-0.330	-0.875	-1.954
	Unit 11	**Unit 12**	**Unit 13**	**Unit 14**	
a	7.2	11.6	11.4	11.6	
b	11.0	7.6	8.2	9.2	
PS	193.99	284.28	319.57	338.69	
IL	-2.844	-0.102	-0.124	-0.091	

RESULTS & DISCUSSION

The measurement results show the maximum gain is 28.2 dB at 18 GHz with 1-dB gain bandwidth of 26.4% from 16.1 GHz to 21 GHz, as given. The half power beamwidth (HPBW) is 6.1° and 5.7° in E-plane and H-plane respectively, with sidelobe of 15.2 dB in both planes. The corresponding aperture efficiency is 35.1%.

It can be seen that although the design frequency of the planar transmission array antenna is chosen to be 15 GHz, the measured maximum gain and center frequency still appear around 18 GHz. Due to the limited bandwidth unit 12-14 and perfect phase compensation at lower frequency, the increment in transmitarray gain gradually decreases with frequency. Considering the gain of feeding horn antenna increases with frequency within the range of 13-23 GHz, the final designed transmitarray antenna keeps a flat gain in the frequency range of 13-23 GHz with wide great 1-and 3-dB bandwidths.





CONCLUSION

In this potter a wideband transmitarray antenna is researched. The achieved 1-dB and 3-dB gain bandwidths are 26.4% and 47.9% respectively, with a measured gain of 28.2dB at 18 GHz and a aperture efficiency of 35.1%. The good property of the transmitarray antenna mainly originates from desirable features of the PCB-based rectangular slot elements, such as low transmission loss and wide transmission phase coverage. Simple structure, high performance and low complexity make it an attractive candidate for the low-cost high-gain wideband transmitarray antenna.