# Microwave energy harvesting using metasurfaces with different polarizations

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The demands on the performance of technology are developing increasingly fast, driving the miniaturization of computing systems. The proliferation of the Internet of Things (IoT) and the development of 5G technology for smart cities and intelligent systems ask more and more supply in energy to power microwatt devices such as sensors and microrobots [1].

In the last decade, the interest in microwave radiation has grown substantially because of its potential to be an ambient source of energy. Indeed, the inherent inefficiency of electromagnetic energy transfer in wireless communication broadcasting systems could be exploited to power microwatt devices.

In order to do so, one needs to collect this energy and convert it into a suitable energy vector. A good candidate to perform this task is the versatile platform of metasurfaces. Over the last decade it has been demonstrated that metasurfaces allow for the control of electromagnetic waves to an unprecedented degree [2].

In this contribution, we discuss the experimental analysis of the response of a rectifying metasurface that captures microwave energy. Different theoretical results are obtained by combining numerical and experimental analyses. In addition, we study the frequency responses of the metasurface for different polarizations, and the response of the structure by stacking several layers of the metasurface with different polarization characteristics. Doing so, we demonstrate that the bandwidth of the frequency response can be extended. Finally, the design of an integrated rectifier circuit is described, where a harvest yield of 60% was obtained.

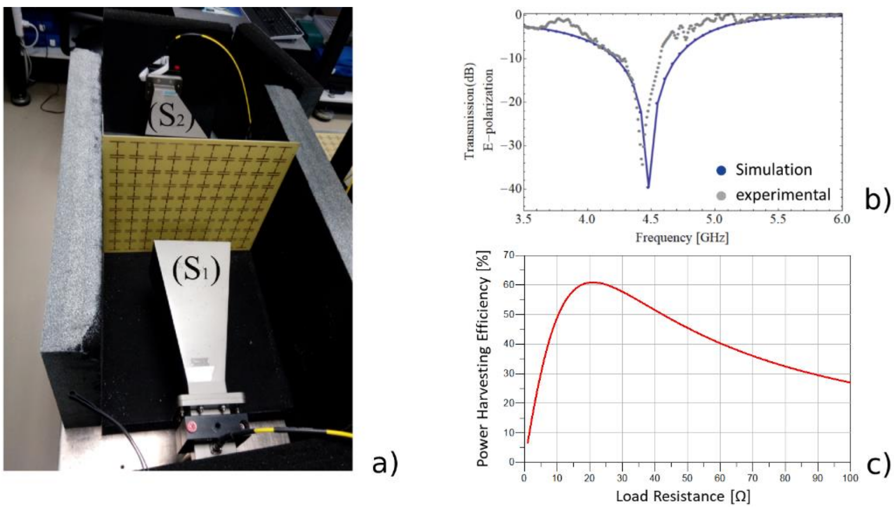


**Fig. 1** (a) Cut-wire metasurface 10×9 in free space, (b) Transmission profile of the metasurface with E-polarization configuration (simulation and experiment), (c) Power harvesting efficiency: RF to DC conversion.

This contribution might be a guide on how to fit the ongoing technology to more sustainable and smart cities in term of energy efficiency [3].

## References

[1] Y. Chen, H. Wang, E. F. Helbing, N. T. Jafferis, R. Zufferey, A. Ong, K. Ma et *al.*, "A biologically inspired, flapping-wing, hybrid aerial-aquatic microrobot," Sci. Robot., vol. 2, 1-11, 2017.

[2] G. T. Oumbe Tekam, V. Ginis, J. Danckaert and P. Tassin, "Designing an efficient rectifying cut-wire metasurface for electromagnetic energy harvesting," Appl. Phys. Lett., vol. 110, 083901, 2017.
[3] R. F. Elgazzar, and R. F. El-Gazzar, "Smart cities, sustainable cities, or both ?," 6th International Conference on Smart Cities and Green ICT Systems, 250-257, 2017.