VUB SCIENCES & BIOENGINEERING SCIENCES

The Research Group

Applied Physics

has the honor to invite you to the public defense of the PhD thesis of

Gabin Thibaut OUMBE TEKAM

to obtain the degree of Doctor of Sciences

Title of the PhD thesis:

Microwave Energy Harvesting Using Metasurfaces

Promotors:

Prof. dr. Vincent Ginis
Prof. dr. Jan Danckaert

The defence will take place on

Thursday July 4 2019 at 16:00h

in the U-Residence, Groene Zaal at the Campus Humanities, Sciences and Engineering of the Vrije Universiteit Brussel, Pleinlaan 2 - 1050 Elsene, and will be followed by a reception.

Members of the jury:

Prof. Laura Honorez Lopez (VUB, chairperson)
Prof. Abdellah Touhafi (VUB, secretary)
Prof. Paul Woafo (VUB & Univ. de Yaoundé)
Prof. Philippe Tassin (Chalmers Univ.)
Prof. Maria Kafesaki (Univ. Of Crete)
Prof. Bart Vermang (Univ. Hasselt)

Curriculum vitae

Gabin Oumbe (° 06 June 1990, Yaoundé, Cameroon) graduated as a Master of Science in Physics: Mechanics and Materials in 2012 from Université de Yaoundé I, Cameroon. After 1 year of research work in Cameroon with two publications in a peer-reviewed international journal as results, he obtained in 2014 a scholarship from the Caribu Erasmus Mundus - Action 2 programme to conduct his PhD at Vrije Universiteit Brussel in the Applied Physics research group (APHY).
His research at VUB focussed on the design of nonlinear metasurfaces for microwave energy harvesting. He has presented his work at international conferences in Europe (3 oral and 3 poster presentations), in America (1 oral presentation) and in Africa (1 oral presentation). He is the first author of a letter in Applied Physics Letters, and 3 international proceedings in the field of Optics and Photonics. He has another manuscript under review.

Abstract of the PhD research

Energy harvesting is the process of harnessing the ambient energy present around us in in the form of vibrations, heat, or electromagnetic waves by converting this energy into electrical energy. Electromagnetic energy harvesting has substantially grown this last decade. This form of energy is particularly interesting because a lot of energy is lost due to the broadcasting inefficiency in wireless communication systems. Converting these microwave energies into a useful power supply is a great challenge, especially because of the low amplitudes of conventional WiFi signals at radio frequencies (RF).

In this work, microwave energy harvesters have been designed, based on subwavelength antennas, arranged on a two-dimensional artificial surface, commonly referred to as a metasurface. Metamaterials in general are artificial materials made of subwavelength electromagnetic resonators that can display non-natural physical properties such as e.g. a negative refractive index. Their size, their shape, their periodicity, and their orientation are parameters that have an influence on their control and manipulation of light.

Gabin Oumbe used metamaterial resonators to amplify the low amplitude of microwave signals and combined these resonators with embedded rectifier circuits. Doing so, he found a way to convert RF power into DC power. Nevertheless, a large enhancement of the electromagnetic field leads to higher radiative losses to the background, which is one of the main limitations for microwave energy harvesting.
He continued his investigation towards nonlinear metamaterial resonators where the radiative losses are separated from the harvesting and rectifying mechanism. This conceptually new approach shows better performance of the microwave energy harvesters, and higher microwave energy harvesting efficiency.

His research followed an iterative approach, using the powerful abstraction of electric equivalent models. The metasurfaces were subsequently simulated using numerical software based on a finite elements method. These analytical and numerical results were also assessed experimentally. One of the biggest challenges remains the integration of rectifier circuits within the metasurfaces.

In summary, the PhD work of Gabin Oumbe contributed to the exciting field of electromagnetic energy harvesting by investigating new physical approaches and techniques for efficient RF to DC energy conversion based on metasurfaces, that operate for realistic microwave input signals.