Ultra-Wideband Nano-Antenna Arrays

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1. Introduction

Efficient ultra-wideband nano-antennas are becoming key components for novel photonic applications, such as energy harvesting and optical sensing of particles, fluid refractive index, chemical and biological agents, etc. Downscaling the well-known configurations of metallic antennas from radio to the optical and infra-red (IR) frequencies offers unique advantages for many of these applications. Furthermore, metallic nano-antennas can be loaded with carbon nano-devices to provide specific functionality. Two types of ultra-wideband highly efficient nano-antenna arrays developed by our group are briefly described below. Also, a novel technique for antenna and load impedance measurements using scattering data will be presented. Various applications of nano-antennas will be discussed.

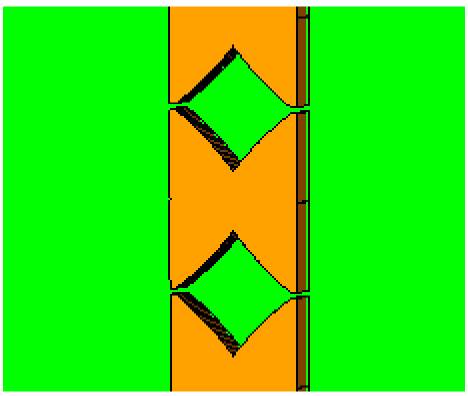
2. Linear-polarized Nano-Antenna Arrays

Dual-Vivaldi nano-antenna (see Fig. 1a) has been proposed to achieve linear-polarized wideband operation at IR and visible frequencies [1]. In this design, two Vivaldi antennas placed on a substrate are operating as a pair (instead of a conventional single element). Such pair of Vivaldi antennas oriented in opposite directions produces the main lobe in the broadside direction (normal to the axes of the antennas), rather than the usual peak gain along the axis (end-fire) of a single Vivaldi antenna. The Dual-Vivaldi nano-antenna arrays were designed, fabricated, and optically characterized in the IR and visible regimes [1]. The radiation efficiency and the spectral response of the antennas were found to be in good agreement with numerical simulations. This nano-antenna has both high radiation efficiency and good impedance matching properties over a wide frequency band. The strong impact of load at the antenna terminals on its scattering response [2] renders the Dual-Vivaldi nano-antennas excellent candidates for optical sensing applications and energy harvesting.

3. Dual-Polarized Nano-Antenna Arrays

A novel nano-antenna array depicted in Fig. 1b is proposed for harvesting and sensing of solar, thermal, and other types of electromagnetic wave energy. This is a dual-polarized receiving array resembling a checkerboard self-complementary geometry [3]. Bimetallic design facilitates implementation of metal-insulator-metal (MIM) rectifiers. Thus, it may be used for wideband energy harvesting and polarimetric sensing at terahertz, IR, and optical frequencies. In polarimetric applications, high isolation between polarizations can be achieved. Moreover, this nano-antenna array design shows high efficiency over a wide range of angles of incidence, high bandwidth, and polarization independence.

(a)



(b)

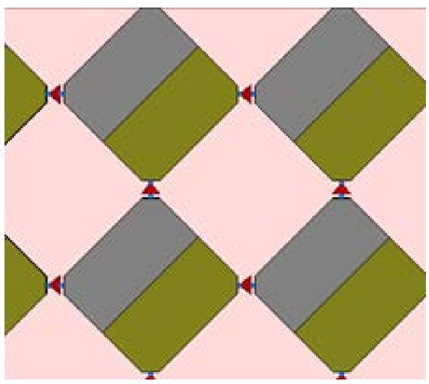


Fig. 1. Nano-antenna arrays: (a) Dual-Vivaldi; and (b) Bimetallic Checkerboard.

4. References

[1] Z. Iluz and A. Boag, “Dual-Vivaldi wide band nano-antenna with high radiation efficiency over the infrared frequency band,” *Optics Letters*, **36**(15), 2773-2775 (2011).
[2] Y. Yifat, Z. Iluz, D. Bar-Lev, M. Eitan, Y. Hanein, A. Boag, and J. Scheuer, “High load-sensitivity in wideband infrared dual-Vivaldi nanoantennas,” *Optics Letters*, **38(**2), 205–207 (2013).
[3] M. Gustafsson, “Broadband array antennas using a self-complementary antenna array and dielectric slabs,” *Ultra-Wideband Short-Pulse Electromagnetics*, **8**, (2007).