PENN CENTER FOR INNOVATION

Nanocircuits at Optical Frequencies

Nanoinductors, Nanocapacitors, and Nanoresistors

Inventor
Nader Engheta

STATE OF DEVELOPMENT

- Prototype

INTELECTUAL PROPERTY

US Patents 9,008,471 & 8,284,477

DESIRED PARTNERSHIP

- License

REFERENCE MEDIA

Engheta et al. (2005) Circuit Elements at Optical Frequencies: Nanoinductors, Nanocapacitors, and Nanoresistors. Physical Review Letters (95) https://arxiv.org/ftp/cond-mat/papers/0411/0411463.pdf

Engheta et al. (2012) Experimental realization of optical lumped nanocircuits at infrared wavelengths. Nature Materials (11) http://www.nature.com/nmat/journal/v11/n3/pdf/nmat3230.pdf

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Problem

Conventional electric circuit elements operate in the radio frequency (RF) domain. However, shrinking circuits down to smaller sizes presents some difficulties as the metallic elements do not behave the same way at the nanoscale. If circuit elements could be created that operate at optical frequencies, they could be made much smaller than conventional electronics. This would require nano-scale circuit elements such as resistors, capacitors, and inductors at sizes orders of magnitude smaller than today's electronics.

Solution

Researchers at the University of Pennsylvania have created nanostructures that act as optical circuit elements. These nanostructures could be used for data storage and computing at scales much smaller than existing devices. The devices are fabricated using certain metals such as gold or silver that exhibit surface plasmon resonance at optical frequencies. Nanoparticles created from a combination of plasmonic (gold, silver) and non-plasmonic materials (Au_2S, SiO_2) can produce properties that will act as inductors, resistors, capacitors, diodes, and inverters in the optical domain. Fabrication and operation of these devices has been demonstrated at infrared wavelengths, using optical nano-circuit elements formed from an array of Silicon Nitride nanorods.

Advantages

- Circuit elements at the nanoscale
- Operation at optical frequencies