Tailoring Optical Nonlinearities via the Purcell Effect

Technology #12647

Applications

The optical nonlinearities are used in telecommunications and quantum computing, enabling optical signal processes such as higher-harmonic generation or optical devices such as optical switches.

Problem Addressed

Optical nonlinearities relate a nonlinear dependence of a polarization of material to optical field strength in the material. Due to the low strength of the optical nonlinearities in optical material, device characteristics are often adjusted to enhance the nonlinearities. The geometry of optical device can be specifically tailored for nonlinear enhancement, but this approach decreases switching speed in the device. Alternative approaches use highly nonlinear materials for optical devices; however, these materials are characterized by other properties that are deleterious for optical processing. Thus, even with optical device geometry and material design that are directed specifically to nonlinearity enhancement, the performance of optical processing and optical devices is constrained by the generally low nonlinearity of optical materials.

Technology

With insights of the Purcell effect for controlling the optical nonlinearity of the device through phase damping, this invention uses nanostructured, solid, nonlinear material which is less than about 10 nm, which can be operated at a temperature of less than about 77 Kelvin, and which electronic bandgap is at least twice as large as an energy of a photon. The invention also includes dielectric structures around the nonlinear material providing a photonic band gap that partially overlaps the electronic bandgap of the nonlinear material. Furthermore, a waveguide is included in the invention which is disposed at the dielectric structure to couple light to the nonlinear material and direct processed light away from the nonlinear material. This system enables a wide range of optical device operations and configurations with operational capabilities not previously attainable. All-optical signal processing devices having operating powers and switching times that are orders of magnitude smaller than those corresponding to traditional nonlinear optical devices are thus attainable.

Advantages

- Nonlinearity enhancement without increased optical absorption or decreased switching speed
- Optical nonlinearities can be tuned and controlled with phase damping to yield a desired output

Categories For This Invention:

Computer Sciences & Information Technology
Signal Processing
Photonics

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Data Communications
Telecommunications

Intellectual Property:

Optical devices having controlled nonlinearity
Issued US Patent
8,369,670

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Publications:

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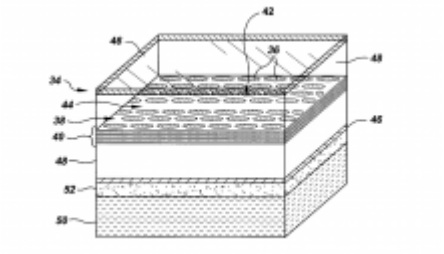
External Links:

Group Link
http://www.rle.mit.edu/marin/

Image Gallery:



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