



Nanoscale Electromagnetic Radiation Device Using Serpentine Conductor

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The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a device for generating electromagnetic radiation using a nanoscale conductive ribbon.

Overview

Electromagnetic radiation may be generated by the acceleration or deceleration of charged particles such as electrons. Synchrotron radiation occurs when the trajectory of high-speed electrons is curved, e.g., as the electrons pass through a magnetic field. This principle is used in a “free-electron laser” (FEL), which uses a transversely aligned magnetic array, or “wiggler,” to produce a disturbance in the path of relativistic electrons. The disturbance results in a conversion of the kinetic energy of the electron beam to electromagnetic radiation. However, while FEL operate in real (3-D) space, they are relatively large.

A “Bloch oscillator” (BO) utilizes the same principle by producing a disturbance of the electrons using the periodic lattice potential of a crystal rather than a magnetic wiggler. When subjected to a constant electric field, electrons accelerate with a BO in a well-defined and repetitive motion. However, a BO cannot operate in real space.

The Invention

UW-Madison researchers have developed a device for generating electromagnetic radiation by accelerating charges on a small serpentine conductor. This nanoscale device incorporates the strengths of both the FEL and BO methods of electromagnetic radiation generation to provide broadband, tunable radiation sources for portable applications.

The electronic device consists of a first and second electrical terminal and a nanoscale ribbon of conductive material providing a serpentine electrical path between the terminals. When charge carriers (electrons) are accelerated in the exposed curve portions of the ribbon, acceleration-induced electromagnetic radiation is emitted. The small dimensions of the ribbon constrain the charge carriers to a series of small-radius curves capable of producing electromagnetic radiation in the microwave range and potentially at light frequencies. The addition of resonant-cavity structures and/or optically active layers produces stimulated emission of coherent, laser-like radiation from a small device. Tuning of the radiation frequencies is possible by physically altering the dimensions of the structure or changing the electrical potential driving the charge carriers.

Applications

- Medical applications such as treatment of acne, cellulite and atherosclerosis
- Telecommunications applications such as portable devices
- Military applications such as missile defense systems
- Materials processing applications

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Key Benefits

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- Expands the market for broadband tunable radiation sources to small-scale, portable and more efficient devices
- Operates in terms of real space similar to FEL applications
- Allows electromechanical tuning of the radiation frequency
- Enables potential operating range on the order of GHz to THz
- Provides a device design possible with available integrated circuit materials and techniques
- Allows for mass production of identical units

Additional Information

For More Information About the Inventors

- [Max Lagally](#).

Publications

- Zhang Y., Yu M., Savage D.E., Lagally M.G., Blick R.H. and Liu F. 2010. Effect of Surface Bonding on Semiconductor Nanoribbon Wiggling Structure. Appl. Phys. Lett. 96, 111904.

Tech Fields

- [Analytical Instrumentation, Methods & Materials : Lasers](#)
- [Engineering : Micro & nanotechnologies](#)

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