TreMonti

External Photoemissive Detector for Long Infrared Wavelengths

Design of an external photoemissive detector for applications involving Detection of Long Infrared Wavelengths

Contact

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Inventor

Clayton W. Bates, Jr., Ph.D.

Field

Opto Electronics & Solid State Physics

Technology

Long Wavelength Infrared Radiation (LWIR) detection

Key Features

- Detects low energy photons
- Eliminates the need of heterojunction barrier
- Fast response ~10^{-10} sec

Stage of Development

Prototype has been developed.

Status

Seeking development & licensing partner.

Patent Status

Patent issued

Technology

Howard University's (HU) professor Dr. Bates's proposed nanophoto emitter technology provides a new application for improvement of detection systems involving long infrared wavelengths.

The basic invention is for the detection of radiation employing the external photoemissive detector. Radiation incident on the photocathode releases electrons that are accelerated by a battery potential and collected in the external circuit as a signal current. Various compound semiconductors may be constructed by varying the relative amounts of the constituents to produce semiconductors with bandgaps varying from 0 electron volts up to over 1 electron volt, suggesting that this method may be employed to detect radiation at very long wavelengths. The external photoemissive scheme of the present invention avoids the limitations of a heterojunction barrier and the necessity of keeping the detector under good vacuum during its operating life. The external photoemissive mode of detection is highly desirable because it is fast ~ 10^{-10} seconds and one can obtain high gains (10^{+5}) with low noise, allowing in some instances the detection of single photon events.

Benefits of the Technology

The key competitive advantages of this invention for applications involving detection of long wavelength infrared radiation (LWIR) can include suitability for applications involving detection of extremely low energy photons that tend to very problematic to detect. This has been possible due to the ability to efficiently absorb at a particular wavelength along with a noise level, which is lower than the signal and thus allowing accurate measurements of the radiation. The detector eliminates the need for a heterojunction barrier and the necessity of keeping the detector under good vacuum during its operating life to achieve the requisite detection capability. The detector can provide extremely fast response times of ~ 10^{-10} seconds and high gains (10^{5}) with low noise- thus enabling the detection of single photon events reliably.

Potential Application for Technology

The IR detector market is estimated to be in the >$1B in North America. Lower cost IR detector systems are opening previously unreachable mass market applications such as driver night vision enhancement for the automotive industry, perimeter detection for security purposes, detection of UV flames for combustion control, surveillance of rockets and intercontinental ballistic missiles, secure space-to-space communication, detection of UV scintillation for medical imaging, monitoring of pollutants like nitrous oxide and sulfur dioxide in the ionosphere in space-based instrumentation for UV astronomy and in UV photolithography for semiconductor processing.

Stage of development

The inventors have created a device that uses different material properties to enable detection of LWIR. The device has been engineered to reliably and effectively detect long wavelength infrared radiation through the use of metal nanoparticles embedded in the semiconductor material. Through the introduction of nanoparticles and other device fabrication changes, they have been able to manipulate the threshold for detection of long wavelength IR radiation to switch from the traditional bandgap property of the detector material to the Schottky barrier property. The impact of this switch is that energy levels that are an order of magnitude lower can now be detected upon impact by low energy photons – thus providing for a much higher level of sensitivity than seen in current devices in the marketplace.

Howard University is looking for a research and/or licensing partner to further develop this system.

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INVENTOR:

Clayton W. Bates, Ph.D.
Professor
Department of Electrical & Computer Engineering

EDUCATION

Ph.D., Physics, Washington University-St. Louis, 1996
M.E., Harvard University

SPECIALTY

Solid-State Physics; Optical and Electronic Transport Properties of Metal-Semiconductor Nano-phase Composite Systems

Relevant Publications:

- Q.Y. Chen and C.W. Bates, Jr., "Geometrical factors in enhanced photoyield from small metal particles", Phys. Rev. Lett. **57**(21), 2737 (1986)
- C.W. Bates, Jr., "Optical properties of metal-semiconductor composites" (review paper), Key Engineering Materials, Vols. **108-110**, pp. 355-380 (1995), Trans. Tech. Publications, Switzerland
- C.W. Bates, Jr. and Q.Y. Chen, "Segregation effects in Ag-Si Composites", Mater. Lett **23**, 7 (1995)
- I. Diagne, J. White, M. / Ndoye, C.W. Bates, Jr. and W.R. Thurber, "Chemical etch studies of Ag/n-Si metal-semiconductor composite films", Mater. Lett. **59**, 1640 (2005)
- C.W.Bates, J.C. White and C. Ekeocha, "Transmission electron microscopy study of Ag/n-Si composites grown on Si (111) substrates", Materials science and Engineering B **143**, 38 (2007)
- C.W. Bates, Jr. and C. Zhang, "Electric field dependence of quantum efficiencies of Ag/n-Si composites in the infrared at room temperature", Jour. Appl. Phys., **104**, 076101 (2008)