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Project Accomplishment Summary

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Sandia National Laboratories
Operated for the U.S. Department of Energy by
Sandia Corporation
Albuquerque, New Mexico

PROJECT ACCOMPLISHMENTS SUMMARY

Cooperative Research and Development Agreement (#SC99157389)

between **Sandia National Labs** and **Lockheed Martin Missiles and Fire Control**

Note: This Project Accomplishments Summary will serve to meet the requirements for a final abstract and final report as specified in Article XI of the CRADA.

Title: MWIR nBn Array Development

Final Abstract:

Sandia National Laboratories (Sandia) and Lockheed Martin Corporation (LMC) have cooperatively developed barrier-type (nBn) photo detectors in the mid-wavelength infrared (MWIR) band for national security applications. Novel materials were developed and characterized, various design parameters were investigated, and the resulting device performance was measured. Significant improvements have been achieved to the state of the art of MWIR focal plane arrays (FPAs), most notably a 50 Kelvin higher operating temperature that allows large reductions in manufacturing and maintenance costs of MWIR sensor systems.

Background:

Many MWIR imaging and monitoring systems utilize InSb FPAs that offer high operability but are required to be cooled to approximately 80 Kelvin. This cooling requirement often results in size, weight, power, and service-life challenges in system integration and use. Sandia and LMC decided to cooperatively develop a new technology to address these challenges by leveraging Sandia's unique III-V compound semiconductor materials and process capability within the MESA R&D complex and LMC's FPA design and manufacturing expertise.

Description:

The main goal of this project was to raise the operating temperature of FPAs by developing a new-class of photo detectors called 'nBn' that utilize III-V compound semiconductor materials. Sandia has a core competency in the design and development of these devices and materials, which were utilized in the execution of this project. Photo detector materials were produced and characterized at Sandia, and FPAs were manufactured from these materials and characterized at LMC. Working together, we achieved approximately 50 Kelvin increase in operating temperature relative to equivalent performance of InSb FPAs. In addition, detector cutoff wavelengths were extended from 4.2um, a lattice matched condition in the Mid-Wave 1 absorption band, to beyond 4.8um in the Mid-Wave 2 absorption band of high interest to IR applications seeking the highest sensitivity and resolution. Mid-Wave Focal Plane Arrays up to 5Mpixel in size were demonstrated at LMC.

Benefits to the Department of Energy:

This project has the potential to enable performance enhancements in space sensors of interest to DOE missions in Nonproliferation and Treaty Verification. Also, new expertise in novel devices and materials has deepened the understanding in the compound semiconductor technology core competency. This is expected to enable new technology options from this competency that will be available to address DOE missions. Non-proprietary knowledge gained from this project has been shared with other service laboratories and academia in the national interest.

Economic Impact:

The technological advances are expected to be implemented by LMC in their future products, potentially replacing a majority of the incumbent InSb FPA technology. There is a need for continued development of production techniques for nBn FPAs, particularly in the growth of detector materials at foundries, which is continuing in a number of programs both internal to LMC and developments funded by DARPA, AFRL and NVESD. The advantages of nBn detectors to provide smaller pixels and higher operating temperature result in size, weight, power, and reliability improvements of the sensor systems, which are expected to be sufficiently large to justify the introduction of the technology for production use.

Project Status:

The project is complete. Period of performance began on May 7, 2008 and ends on July 17, 2013.

ADDITIONAL INFORMATION

Laboratory/Department of Energy Facility Point of Contact for Information on Project

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Company Size and Points of Contact

Lockheed Martin Corporation, Missiles & Fire Control, Santa Barbara Focalplane
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CRADA Intellectual Property

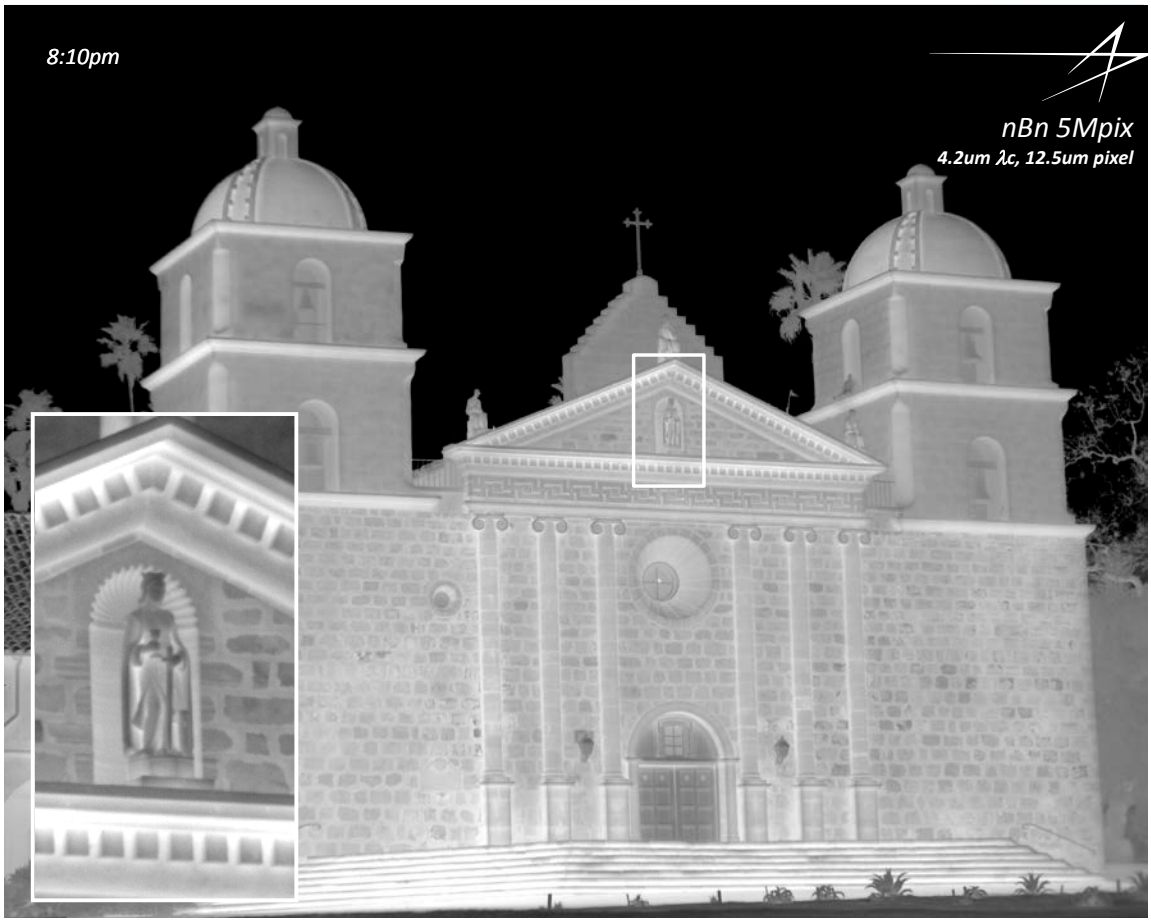
SD 11500: Strain-compensated InAsSb absorber
SD 11527: Improving surface and interface smoothness of InAsSb digital alloy

Technology Commercialization

LMC is currently maturing the nBn Focal Plane Array for insertion into the Advanced Electro-Optic Targeting Sensor used on the F-35 Joint Strike Fighter. Work is being funding in a combination of LMC Internal Research and Development and government Contracted Research and Development.

Project Examples

Very Large Focal Plane Arrays have been produced using nBn detector materials. Below is an example image with a 5Mpix Digital Focal Plane Array using a 2560x2048 12.5um pitch format taken in 2011.


8:10pm
nBn 5Mpix
4.2um λc, 12.5um pixel

formation

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This summary has been approved for public release by Sandia and Lockheed Martin Missiles and Fire Control

Sandia National Laboratories

By _____ 7/18/2013
Jin K. Kim — Date
Principal Investigator

Sandia National Laboratories

By _____ 7.15.13
Manager — Date
WFO/CRADA Agreements

Lockheed Martin Missiles and Fire Control

By _____ 7/23/13
Title: Principal Investigator — Date
LM Fellow

In order to expedite the process, if we do not receive your signed reply by 08/18/2013 we will assume your concurrence for the release of this document to the public.