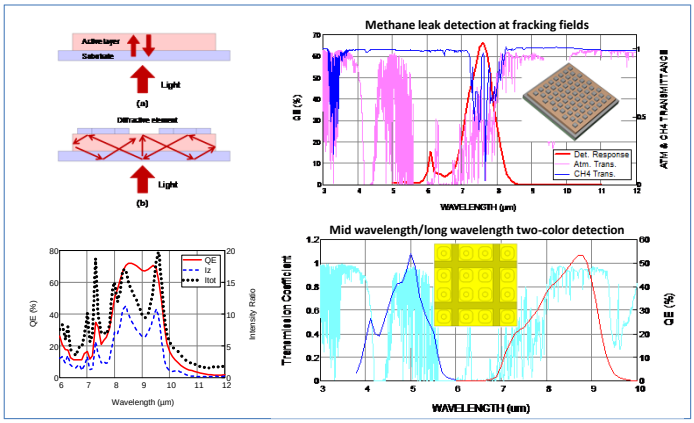
Resonant structures for IR detectors

S&T Campaign: Materials Research
Photonics

Dr. K K Choi, (301) 394-0495
Kwong.k.choi.civ@mail.mil

Research Objective

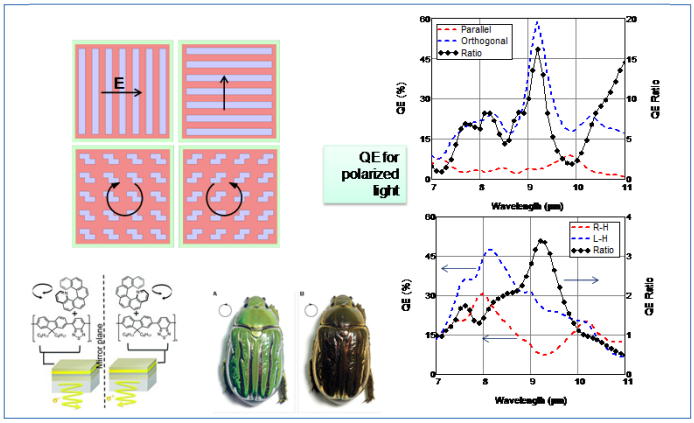
- To invent novel resonant structures for new IR sensor functionality and capability, and to develop suitable IR materials for concept implementation.
- To build a scientific foundation for a new economical and capable infrared technology.



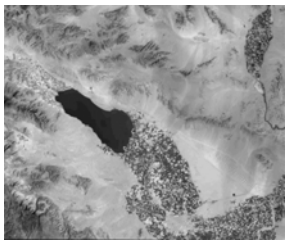
By deflecting light sideway, light can be confined in 3-D, with which the internal intensity can increase by ~20 times, thus facilitating detection at different resonant wavelengths.

Challenges

- Identify a more effective detector structure to increase internal optical intensity.
- Identify a better IR material to implement the concept.
- Include advanced optical effects such as quantum optics, transformation optics, and metamaterials in the design.
- Invent effective structures for real-time wavelength tuning and for polarization detection.



Examples of photon traps for different optical polarizations.



QWIP FPA imageries from the air and from space obtained in ARL collaborations

ARL Facilities and Capabilities Available to Support Collaborative Research

- Experimental laboratory facilities: Several labs at Adelphi for detector and focal plane array characterization.
- Specialized modeling/simulation tools and facilities: High Performance Computing at Aberdeen Proving Ground.
- Unique detector and FPA fabrication facilities: SEMASC at Adelphi.
- Patents and references:
  – K. K Choi, Photodetectors using resonance and method of making, U.S. Patent 8704209 (2014).
  – K. K. Choi, Computer designed resonant detectors and method of making, Patent pending, Pub. No.: US 2013/0145330 A1 (2013).
  – K. K. Choi, et. al., Electromagnetic Modeling and Resonant detectors and Arrays, Inf. Phys. & Tech. 2014, DOI information: 10.1016/j.infrared.2014.09.009.
- Unique ARL expertise: II-VI and III-V IR material growth, EM modeling, device and FPA fabrication and testing.
- Significant early findings: Realized QE up to 71% in QWIPs and verified the approach in InAsSb-based nBn detectors.

Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- List known capabilities needed:
  – Nano-lithography to extend light trapping to short wave infrared detectors and visible solar cells.
  – Growth of new IR materials suitable for light trapping.
- Specialized laboratory facilities not available at ARL: Test of photon trap focal plane arrays in realistic environments.
- Expertise in a specific scientific or technical area:
  – Quantum optics, transformation optics, and metamaterial theory and modeling for detector design.
  – Readout electronic design for photon trap FPAs.
- Suggestions for innovative new research: New ideas in increasing optical absorption in thin, anisotropic, and weakly absorbing materials.

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED