MWIR Resonant Cavity Infrared Detectors (RCIDs) with High Quantum Efficiency and High Frequency Response

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NRL recently demonstrated the first MWIR resonant cavity IR detectors (RCIDs) to exhibit high performance [1]. At resonance wavelength λ_{res} = 4.0 μm, devices with a grown GaSb/AlAsSb bottom mirror, dielectric top mirror, and absorber thickness of only 50 nm attained external quantum efficiency EQE = 34%, with linewidth 46 nm. U. Lancaster subsequently reported RCIDs with InAs absorber displaying $\lambda_{res} \approx 3.3$ μm and 52% EQE [2].

Here we report devices for which an *nBn* detector chip with 20 InAs/InAsSb active quantum wells and total absorber thickness 103 nm was bonded to a GaAs/AlGaAs mirror with reflectivity > 99%. The GaSb substrate was then removed, and mesas processed from the back side of the as-grown detector epitaxy. The RCID's very thin absorber allows rapid extraction of the photoexcited carriers for high frequency response. For a device with small diameter (d = 21 μm) for reduced capacitance, the optical heterodyne data illustrated in Fig. 1 (taken before the top dielectric mirror was deposited) confirm a 3dB response of 5.9 GHz. The EQE spectrum for a larger RCID (d = 105 μm) was measured with an FTIR by fitting the ratio of photocurrent to measured blackbody flux through a calibrated narrowband filter (blue curve in Fig. 2). This yielded peak EQE = 57% at λ_{res} = 4.618 μm, with FWHM = 31 nm. EQEs for the same device were also characterized from the photocurrent induced by excitation from a quantum cascade laser (QCL) with calibrated incident power, in independent measurements at NRL (blue points) and Intraband, LLC (red points).

Figure 1 – Frequency response of an RCID with d = 21 μm.

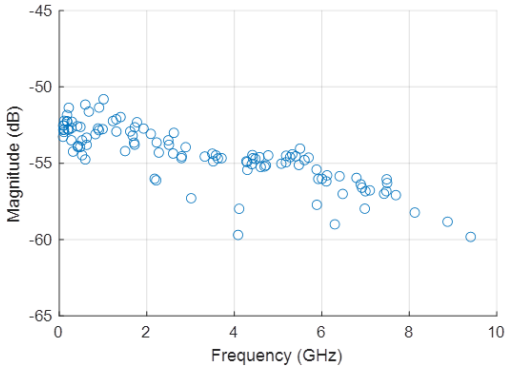
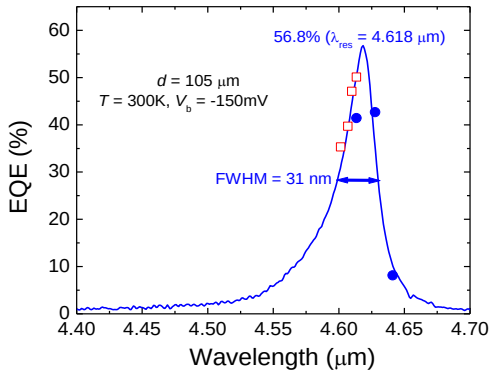


Figure 2 – EQE *vs.* wavelength for an RCID with d = 105 μm, as measured by three experiments.



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[2] A. Bainbridge *et al.*, *phys. stat. sol. (a)* **218**, 2100056 (2021).
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