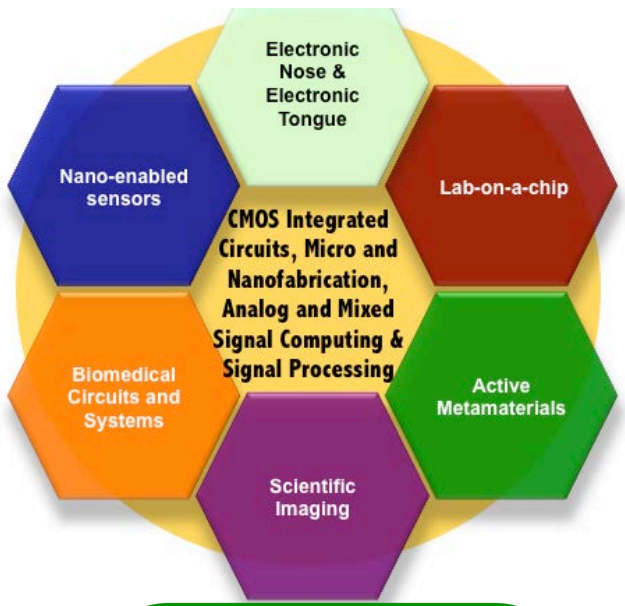
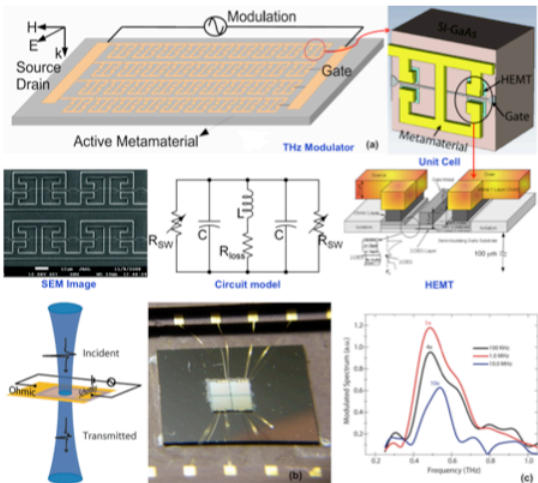


# Sameer Sonkusale, Tufts University



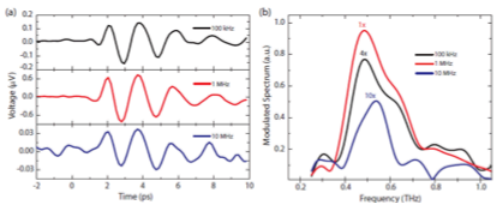
## Active Metamaterial Modulators



Hybridization of metamaterial with pHEMTs

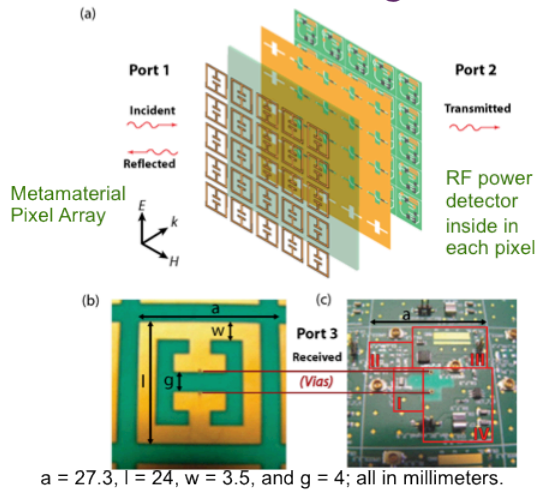
**Technology:** 0.5 um GaAs HEMT technology with 3200 periodic unit cells on area of 2.7x2.6 mm<sup>2</sup>

**Results:** THz time-domain spectrometer (THz-TDS) characterization shows resonance frequency of 0.46 THz and modulation index of over 30% for frequency >10 MHz

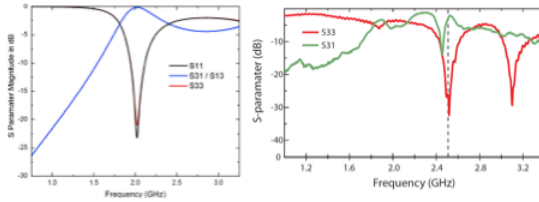


(a) Transmitted time dependent electric field for modulation at frequencies of 100 kHz, 1 MHz and 10 MHz. (b) Transmitted spectra calculated from the time domain data.

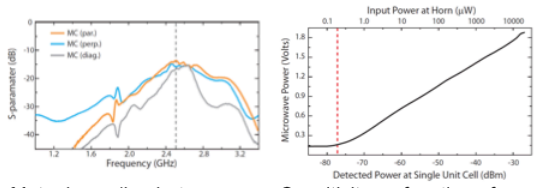
## Active Metamaterial Detectors/Imagers



a = 27.3, l = 24, w = 3.5, and g = 4; all in millimeters.



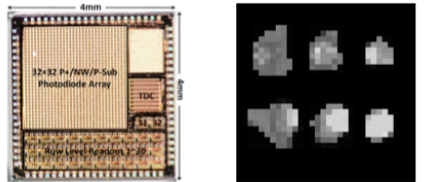
Reflection coefficient ( $S_{33}$  red curve) and the transmission ( $S_{31}$  green curve) with the dashed grey line at 2.5 GHz, which is the resonant frequency.



Mutual coupling between neighboring unit cells—metrics of pixel channel independence  
Sensitivity as function of incident radiation power  
Result > -77dBm @2.5 GHz

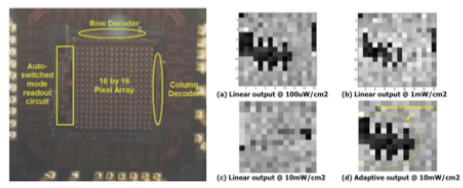
## CMOS Scientific Imagers

### Fluorescence Lifetime Imaging Chip



2D Oxygen Dependent Lifetime Image

### 120-dB linear-log HDR imager



(a) Linear output @ 100W/cm<sup>2</sup> (b) Linear output @ 1mW/cm<sup>2</sup> (c) Linear output @ 10mW/cm<sup>2</sup> (d) Adaptive output @ 10mW/cm<sup>2</sup>