
Electrical & Computer Engineering
S E M I N A R
Louisiana State University

**Uncooled Semiconducting YBaCuO
Infrared and Far-Infrared Detectors**

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Abstract—A new generation of microbolometers were designed, fabricated and tested for the NASA CERES (Clouds and the Earth's Radiant Energy System) instrument to measure the radiation flux at the Earth's surface and the radiant energy flow within the atmosphere. These detectors are designed to measure the earth radiances in three spectral channels consisting of a short wave channel of 0.3 to 5 μm , a wide-band channel of 0.3 to 100 μm and a window channel from 8 to 12 μm each housing a $1.5 \times 1.5 \text{ mm}^2$ microbolometers or alternatively $400 \times 400 \mu\text{m}^2$ microbolometers in a 1×4 array of detectors in each of the three wavelength bands. The microbolometers were fabricated by radio frequency (RF) magnetron sputtering at ambient temperature, using polyimide sacrificial layers and standard micromachining techniques. A semiconducting YBaCuO thermometer was employed. A double micromirror structure with multiple resonance cavities was designed to achieve a relatively uniform absorption from 0.3 to 100 μm wavelength. Surface micromachining techniques in conjunction with a polyimide sacrificial layer were utilized to create a gap underneath the detector. The temperature coefficient of resistance (TCE) was measured to be 2.8%/K. These devices have successfully demonstrated voltage responsivities over 10^3 V/W , detectivities above $10^8 \text{ cm Hz}^{1/2}/\text{W}$ NEP less than $4 \times 10^{-10} \text{ W/Hz}^{1/2}$ and thermal time constant less than 15 ms. The second part of the talk describes a new micromachined microbolometer array structure that utilizes a self-supporting semiconducting YBaCuO thin film thermometer. The YBaCuO thermometer is held above the substrate only by the electrode arms without the need of any underlying supporting membrane. This represents a significant improvement in the state-of-the-art for microbolometers by eliminating the thermal mass associated with the supporting membrane. The reduced thermal mass permits lowering the thermal conductance to the substrate to obtain increased responsivity or having a shorter thermal time constant to allow for higher frame rate camera. Devices were fabricated by growing YBaCuO films on a conventional polyimide sacrificial layer mesa. Subsequent etching of the sacrificial layer provides the air gap that thermally isolates the microbolometer. The measured TCE was 3.1%/K at room temperature. The measured responsivity and detectivity approached 10^4 V/W and $10^8 \text{ cm Hz} /\text{W}$. The micromachining techniques employed are post-complementary metal-oxide-semiconductor (CMOS) compatible, allowing for the fabrication of focal plane arrays for IR cameras.

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Info: <http://www.ece.lsu.edu/seminar>