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Thermoelectrically Coupled Nanoantennas for Solar Research

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We are developing thermoelectrically coupled nanoantennas (TECNAs) asinfrared (IR) sensors for applications in solar imaging in the mid- and far-IR, both terrestrially and for future space missions. Nanoantennas are nanoscale structures that interact with light in the same way that macroscale antennas interact with radio waves. The electric field of the electromagnetic wave causes electron currents in the antenna, Which interact with an amplifier to produce a signal. In our nanoantennas, the electric field of the IR radiation induces electron currents that heat the nanowire antenna and, subsequently, a nanothermocouple that provides the signal to our amplifier. IR sensors exhibit various characteristics that include wavelength selectivity, sensitivity (specific detectivity,D*, or noise equivalent temperature difference, NETD), speed cadence), polarization sensitivity, operating temperature, directionality, power consumption, and cost of manufacture. Various commercial IR sensors excel in one or only a few of these characteristics. Our uncooled IR detectors can be made sensitive from a few microns to sub-THz, and compete very favourably in all of these characteristics, except for sensitivity, in a single general design. This talk will cover the motivation for developing TECNAs for solar imaging, nanothermocouples, including a 'monometallic nanothermocouple' developed at Notre Dame, thermal and electrical properties of our nanoantennas, fabrication, performance of cadence into the 100s of kHz, and polarization sensitivity. We will conclude by discussing potential avenues for improving D* and NETD. This work is supported by NSF and NASA.