NORMAL-INSULATOR-SUPERCONDUCTOR JUNCTIONS WITH MICROWAVE READOUT FOR LARGE ARRAYS OF ULTRALOW NEP BOLOMETERS

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We are developing antenna-coupled hot-electron bolometers based on normal-insulator-superconductor (NIS) tunnel junctions. These junctions make electrical contact to a small normal metal island while preserving its thermal isolation. Their current-voltage curves are used to monitor the response of the island temperature to incident power. We have recently measured a NET of 0.6 μK/rt Hz at 270 mK in a prototype device with a normal volume of 4.5 μm^3 and infer an NEP of $7*10^-17$ W/rt Hz. Our devices incorporate two recent advances: 1) improved designs for NIS structures in which the application of a bias refrigerates the normal metal, thus providing lower effective operating temperatures and increased resistance to saturation, and 2) microwave readout in which the device is imbedded in an impedance transforming resonant circuit that reflects a microwave drive signal into a HEMT amplifier. This readout technique is compatible with multiplexing tens to hundreds of sensors per HEMT. It is also compatible with high bandwidth measurements such as far-infared photon counting. To achieve lower NEPs, we are now building devices with smaller volumes, lower operating temperatures, and integrated heaters for exact power calibration. The anticipated limits on NEP and array size will be discussed. Since our sensing elements are made with a robust, wafer-scale photolithographic process, large arrays are straightforward to fabricate. Electromagnetic simulations indicate that it is possible to integrate these bolometers into dual slot antenna structures with high coupling efficiencies near 1 THz. These devices will be suitable for a number of applications in far-infrared and submillimeter astronomy.

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