Feedhorn-Coupled Transition Edge Sensor Arrays for Measurement of the Cosmic Microwave Background Polarization

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Characterization of the minute cosmic microwave background polarization signature requires multi-frequency high-throughput precision instrument systems. We have previously described the detector fabrication of a 40 GHz focal plane and now describe the fabrication of a 37-element dual-polarization detector module for measurement of the CMB at 90GHz. The 72-TES based bolometers in each module are coupled to a niobium based planar orthomode transducer with integrated band defining filters implemented in microstrip transmission line. A single crystal silicon dielectric substrate serves as microstrip dielectric and as a thermal link between the membrane isolated MoAu TES operating at 150mK and the heat bath. A short silicon leg between the heat bath and the TES bolometer is designed for ballistic phonon transport and provides improved process control and uniformity of thermal conductance in the presence of phonon scattering on roughened surfaces. Micro-machined structures are used to realize the orthomode transducer backshort, provide out of band signal rejection, and a silicon photonic choke for feedhorn coupling are described. The backshort, choke wafer, and detector wafer are indium bump bonded to create a single 37-element dual-polarization detector module. Fourteen such hexagonally shaped

modules each 80mm in size comprise two focal planes. These, along with the recently delivered 40GHz focal plane, will survey a large fraction of the sky as part of the Johns Hopkins University led ground based CLASS (Cosmology Large Angular Scale Surveyor) telescope.