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Fabrication of silicon-supported germanium blocked impurity band detectors for infrared astronomy

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Far infrared(FIR) wavelength (30 - 200 μm) is important spectral window to study the formation of planets, stars and galaxies. Germanium Blocked Impurity Band (Ge BIB) detectors respond sensitively to FIR photons of those wavelengths, which have cut-off wavelength significantly longer than Ge photoconductors without applying mechanical stress. Ge BIBs are consisting of an IR active layer, Ge:Ga with Ga concentration high enough to form an impurity band, and a blocking layer, high-purity Ge to block the impurity band conduction of active layer. Thicknesses of both layers are
approximately 5 μm and they are mechanically supported on a thick (500 μm) and IR transparent Si substrate. We develop the detector chips composed of Ge BIBs and readout integrated circuits (ROICs) made of fully-depleted silicon-on-insulator (FD-SOI). The Ge BIB is mounted on the ROIC by nano-particle deposition (NpD) Au-bump bonding.
The detector chips are operated under a cryogenic temperature such as 2 K. In this environment, difference in the coefficient of thermal expansion (CTE) between Ge-based BIB detectors and Si-based ROICs generates stress on Au-bump which connects them mechanically and electrically. In this study, the Si-supported Ge BIB structure is employed to overcome this problem. CTE of the Si-supported structure composed of thick Si with two thin Ge layers is expected to be dominated by the Si substrate. Therefore, the thermal stress due to CTE mismatch between Ge BIB and Si ROIC is mitigated.
Si-supported Ge BIB wafers are fabricated by using room-temperature surface-activated bonding (SAB) technique as well as grinding and chemical mechanical polishing technique. Further, the wafers are processed into BIB detectors which have a 32x32 or 5x5 pixel array.
In this presentation, the current status of the fabrication of Si-supported Ge BIB detectors will be reported.

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