Development of Silicon Based Integrated Receivers

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***Abstract*— Submillimeter heterodyne instruments have played a critical role in addressing some of the fundamental questions regarding galaxy evolution as well as enhancing our understanding of the planet that we live on. To make these instruments compatible on small platforms for the study of the outer planets, it is essential to make them low-mass and low-volume. At JPL, we have developed over the years a world-class expertise in fabricating GaAs Schottky diode based integrated circuits for sub-millimeter and THz applications. Normally, the mixer and the multiplier chips are packaged in separate metal-machined waveguide blocks and then mated together to form part of the receiver front end. We now can utilize technologies from the semiconductor micro-fabrication arena to design and fabricate super-compact receiver packages. One way to make highly integrated, compact, and low-mass receiver front-end is to make the waveguide in silicon where the power amplifiers, multipliers, and mixer chips can be integrated in a single silicon micromachined block (Figure 1). We have developed DRIE processes to etch silicon wafers (Figure 2) and using these techniques, we have designed, fabricated and characterized an integrated receiver architecture called Radiometer-On-a-Chip (ROC). The stacking of micro-machined silicon wafers allows for the 3-dimensional integration of the W-band power amplifier, a 280 GHz tripler and a 560 GHz sub-harmonic mixer in an extremely compact package. Preliminary results give a DSB mixer noise temperature of 4860 K and DSB mixer conversion losses of 12.15 dB at 542 GHz and they demonstrate that Si micromachining technology can be used for building THz components and systems.**

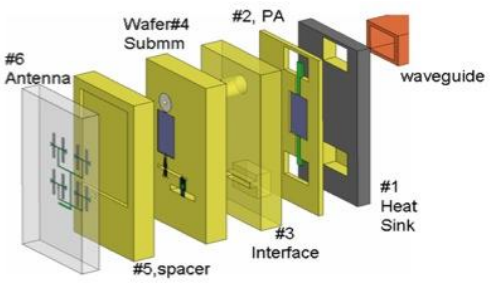

Fig 1: Stack of 6 different Si wafers to provide functionality of a single-pixel receiver front end.

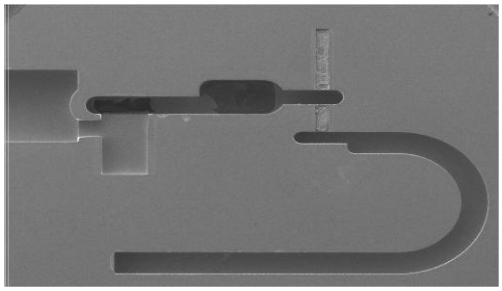

Fig 2: SEM picture of Si-etched cavities and waveguides for the 560GHz Radiometer-On-A-Chip architecture.

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