Fabrication of Plate-laminated Waveguide for 350GHz Band by Silicon Process

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This paper presents the fabrication of plate-laminated waveguides and cavities for 350GHz band by silicon process where the tolerance is less than several μm. We measure the transmission loss of the waveguide and the Q factors of the cavities, and then estimate the equivalent conductivity. We will also fabricate the plate-laminated waveguide slot array antennas (Y.Miura, J.Hirokawa et al., *IEEE Trans. Antennas Propagat.*, **59**, 2011, pp.2844-2851) and show the measured results in the conference.

We use three silicon wafers polishing the both sides. The diameter is four inches and the thickness of each wafer is 0.2mm. The fabrication process is as follows. (1) We etch the patterns. The middle wafer has the patterns for three straight waveguides and two rectangular cavities. The waveguide width is 0.5mm. The lengths of the waveguides are 20mm, 40mm and 60mm. The two cavities are identical to each other. The cavity is connected two waveguides at the both ends and it is designed to have transmission of -24.5dB for the conductivity of $5.8\text{x}10^7$S/m (standard value for cupper) at 350GHz. The both ends of the waveguides have a transition to WR-3 standard waveguide with an input aperture etched on the bottom wafer. The top wafer is a cover to compose the waveguides and the cavities. (2) Au films are formed by electroplating with the thickness of more than 1μm over all the surfaces of each wafer to avoid the loss by silicon. Cr is formed by electron beam evaporation to get good contact between the silicon and the gold. (3) We join the three wafers with heat around 300 degrees Celsius and pressure of about 9kN in vacuum.

The transmission loss of the waveguide is a range of 0.9-1.3dB/cm around 350GHz from the measured transmission of the three waveguides. The effective conductivity by estimating this transmission loss is a range of $2.6\text{-}5.4\text{x}10^7$S/m. The measured resonant frequencies of the two cavities are 351GHz and 354GHz, respectively. The measured Q factors of the two cavities are 970 and 780, respectively. The effective conductivity by estimating these Q factors is a range of $4\text{-}5\text{x}10^7$S/m. The measured transmissions of the two cavities are -26.5dB and -30.5dB, respectively. The effective conductivity by estimating these transmissions is a range of $1.6\text{-}3.8\text{x}10^7$S/m. At this moment, the effective conductivity is deviated among the three estimations, however it is more than 1.6 $\text{x}10^7$S/m around 350GHz.

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