Fabrication of HEB Mixers Using Substrate Heating in Combination with the AlN Buffer Layers

R.Furuya[1*], T.Shiino,[1] T.Soma[1], O.Ohguchi[1], H.Maezawa[2], N. Sakai[1], and S.Yamamoto[1]
1 University of Tokyo, School of Science, Bunkyo, Tokyo, 113-0033, Japan*
2 Osaka prefectural University, School of Science, Sakai, Osaka, 599-8531, Japan
* Contact: furuya@taurus.phys.s.u-tokyo.ac.jp, phone +81-3-5841-4217

***Abstract*—An HEB mixer is the most sensitive heterodyne mixer above 1.3 THz, and extensive efforts have been done for its development during the last decade. One of the important issues for the HEB mixer is to extend its IF bandwidth. In contrast to the SIS mixer, the IF bandwidth is actually limited by the cooling time of the superconducting microbridge. In the NbTiN HEB mixer, this cooling is done through phonons, and hence, the heat produced in the microbridge by absorption of the THz photons is eventually escaped to the substrate. To make this mechanism work efficiently, we need the very thin superconducting film with high critical temperature. In order to fabricate such a high quality superconducting film, we have employed the substrate heating during the deposition of the NbTiN film by reactive sputtering of the NbTi target. When we deposit the NbTiN film on the AlN buffer layer on the glass substrate heated up to 600℃, the superconducting behavior is found to be improved dramatically. In the case of the 8 nm NbTiN film, *T*c is improved by 4 K or more. Then, we have involved this method into our fabrication process of the HEB mixer. For this purpose, we have to use the etching process to make contact pads instead of the lift-off process previously used in our fabrication process. Using this new process, we have succeeded in fabricating the waveguide type HEB mixer having 3 nm thickness NbTiN microbridge. The thickness of the microbridge is less than 1/3 of that of our previous mixer (10.8 nm). We have achieved the noise temperature of 480 K at 809 GHz, where *T*c is 7.5 K. We have also measured the IF bandwidth of this HEB mixer, and have confirmed that the 3 nm thickness HEB device has the IF bandwidth up to 2.8 GHz. Although we have not measured the IF response above 3 GHz due to the limitation of the IF amplifier chains, it seems likely that the mixer can work at higher frequencies than 3 GHz of IF frequency.**