GAIN BANDWIDTH OF PHONON-COOLED HEB MIXER MADE OF NBN THIN FILM WITH MgO BUFFER LAYER ON Si

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There is an interest in the Terahertz community to increase the IF bandwidth of phonon-cooled HEB mixer that is recently the most low noise mixing device for frequencies over 1 THz. In this frequency range there are no tunable sources and therefore mixing device should have maximum gain bandwidth near local oscillator frequency.

Practically NbN HEB mixer IF bandwidth is limited mostly by acoustic transparency mismatch of the film-substrate interface. For example gain bandwidth reaches 3.5-4.5 GHz for 3.5 nm thick NbN film on Si substrate. Since the choice of substrate material that fits the process of fabrication of low noise terahertz HEB mixers and quasioptical or waveguide reciever technology is limited it seems that a perspective approach is to find a buffer layer between NbN film and substrate. Several materials have been already studied for their ability to work as a buffer layer. We have found that MgO improved acoustic transparency. This buffer layer was used in waveguide mixer on quartz substrate and showed good characteristics [1]. MgO buffer layer makes the film more homogeneous and therefore critical current reaches values twice greater than earlier. Recent improvements in process of fabrication of HEB mixers allowed to create devices with film thickness less than 3.5 nm. MgO buffer layer significantly increased critical temperature (Tc) from 9 K to 10.5K for 3 nm thick NbN film and from 10 K to 11.5 K for 4 nm.

We will present results on superconducting characteristics of NbN thin films with MgO buffer layer on Si substrate and for gain bandwidth of HEB mixers with spiral antenna based on these films for frequencies 300 and 900 GHz. DSB noise temperature of terahertz receiver based on this mixer was measured for LO frequency 2.5 THz [2].

References

[1] Denis Meledin, Edward Tong, Raymond Blundell, Natalia Kaurova, Boris Voronov and Gregory Goltsman, "Sensitivity and IF bandwidth of waveguide NbN phonon-cooled HEB mixers based on crystalline quartz substrate with MgO buffer layer", Thirteenth International Symposium on Space Terahertz Technology, this conference.

[2] Alexei D. Semenov, Heinz-Wilhelm Hübers, Heiko Richter, Manfred Brik, Michael Krocka, Ulrich Mair, Konstantin Smirnov, Gregory N. Gol'tsman and Boris M. Voronov, "Superconducting hot-electron bolometer mixer for terahertz heterodyne receivers", Thirteenth International Symposium on Space Terahertz Technology, this issue.