Low Noise Terahertz Mixers made of MgB_2 Films

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Mixers based on Hot-Electron Bolometers (HEB) are used for low noise detection in radio astronomy at frequencies above 1THz as e.g. in [1]. The majority of HEB mixers are made of very thin superconducting NbN films, where a short electron-phonon interaction time (10 ps at 10 K) and a short phonon escape time (40 ps for 5nm) insures a gain bandwidth (GBW) of about 3-4 GHz. In some cases, for very short length NbN HEBs, the GBW can be extended to 7-9 GHz. The critical temperature of the used NbN films is about 9-11 K, and hence, there is no much choice as to cool the devices to 4K or even below. Obviously, there is an interest if other materials can be utilized for the HEB mixers with a competitive or even superior performance with a possibility of operation at high temperatures.

In ref [2] we demonstrated that a short electron energy relaxation time can be achieved in thin magnesium deboride (MgB_2) films (T_c>20K). Later [3, 4], a low noise temperature (600 K) and a wide GBW (3.4 GHz) was reported for MgB_2 HEB mixers at 600 GHz.

In this contribution we will report on the MgB_2 HEB mixer performance above 1 THz, where a wide noise bandwidth has been achieved. We will also discuss the progress and challenges in fabrication of high quality and very thin MgB_2 films using a method of Physical Chemical Vapor Deposition.

References

1. S. Cherednichenko et al, "Hot-electron bolometer terahertz mixers for the Herschel space observatory," *Review of Scientific Instruments*, vol. 79, no. 3, pp. 034501–10, Mar. 2008.

2. S. Cherednichenko et al, "Terahertz mixing in MgB microbolometers," *Appl. Phys. Lett.*, vol. 90, no. 2, p. 023507-3, Jan. 2007.

3. S. Bevilacqua et al.,"Low noise MgB terahertz hot-electron bolometer mixers," *Appl. Phys. Lett.*, vol. 100, no. 3, p. 033504-3, Jan. 2012.

4. S. Bevilacqua et al.,, "Study of IF Bandwidth of MgB2 Phonon-Cooled Hot-Electron Bolometer Mixers," in IEEE Transactions on Terahertz Science and Technology, 3 (4) s. 409-415.