Noise in Nano Bolometers: Terahertz Detectors at Room Temperature and at 77K

Stella Bevilacqua, Aurel Bergfalk, and Sergey Cherednichenko

Department of Microtechnology and Nanoscience (MC2)
Chalmers University of Technology, SE-41296 Göteborg, Sweden
Email: stellab@chalmers.se

The diversity of THz detectors is as wide as the range of applications for THz waves. Requirements for the detectors vary and so do the detectors. Extremely high sensitivities (NEP<10^{-18} W/$Hz^{0.5}$) for the cosmic microwave background and extragalactic observations can only be achieved with the detector cooling below 1K. Whereas, simplicity and robustness are required for generic THz detectors in a lab. Security imaging needs THz detectors in large arrays, preferably at ambient temperature operation or with compact and lightweight cooling. Until recently, such characteristics as good sensitivity (NEP<1 nW/$Hz^{0.5}$), high speed (< 1 ms), potential for integration in arrays (solid state technology), room temperature operation have been demonstrated only with Schottky barrier diodes. Si FET detectors have also shown a good performance below 1THz. In our previous work we demonstrated [1, 2] that with a micro- and nano- meter scale bolometers based on YBa2Cu3O7-x, (YBCO) thin films, an NEP of 200 pW/$Hz^{0.5}$ is achievable at room temperature, with a response rate as short as a few nanoseconds (2-5 ns).

In this contribution we will report on the YBCO nano bolometers as small as 100nm. It leads to a large increase in the responsivity (>100V/W) for frequencies from 100GHz to 2THz. As the responsivity grows, the nano bolometers become more sensitive to the external electrical disturbances, which can be confused with intrinsic noise in the device. We will discuss the noise properties of the YBCO nano bolometers, their optical characterization, as well as some of their application for the gas spectroscopy and prospects of the array integration.

References

1. S. Cherednichenko et al., “A room temperature bolometer for coherent and incoherent detection,” IEEE Trans. Terahertz Science and Technology, v.1, n.2, pp.395-402, Nov. 2011

2. S. Bevilacqua et al, “Fast room temperature THz bolometers,” in Proc. 38th International Conference on Infrared, Millimeter and Terahertz Waves (IRMMW-THz), 1-6 Sept. 2013, DOI: 10.1109/IRMMW-THz.2013.6665544.