Use of Topological Insulators as wide-band photodetectors

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Abstract: Topological Insulators represent a unique state of matter, being insulating in the bulk and hosting Dirac helical states on the surface. Experimental results on Topological Insulator based wide band photodetectors are reported.

Topological Insulators (TIs) exhibit properties that are particularly important for high responsivity and fast photodetectors. In particular, they possess the unique property of being insulating in the bulk while hosting a high-mobility Dirac electronic surface state [1]. These characteristics give these materials the possibility to absorb radiation in the bulk and deliver the produced photocharges at high speed through the high mobility surface states.

Among TI, Bi2Se3 is one of the most studied as a photodetector because of its bulk electronic bandgap of 0.3 eV, which gives the possibility to operate at telecommunication wavelength (1550 nm) [2]. When in contact with a doped semiconducting substrate, the metallic nature of the Bi2Se3 surface gives rise to the formation of a Schottky junction, which operates as a fast photodetector [3]. In addition, the high mobility Dirac surface states favour the delivery of the collected photocharges to the external circuit, resulting in high responsivity and high detectivity operation [4].

We report our experimental results concerning the possibility of obtaining high responsivity photodetectors by using Bi2Se3/n-Si heterojunctions with the thickness of Bi2Se3 between 10 nm and 100 nm [6]. In this device, Bi2Se3 represents the absorbing layer. Depending on its thickness, this material can be used at different wavelengths since the light penetration depth ranges from 20 nm to 150 nm for radiation wavelengths from visible to near infrared (NIR), respectively.

In order to improve the performance of the detectors, a new strategy was recently adopted. A layer of Tellurium is deposited on the top of the Bi2Se3 surface, such that a Te/Bi2Se3/n-Si stacked structure is created. The choice of Te is because of its higher optical absorbance with respect to BieSe3 at λ=1550 nm. Moreover, the double Schottky interface between Bi2Se3 and n-Si and between Te and Bi2Se3 would favour the photocharge separation and its delivery towards the external circuit.

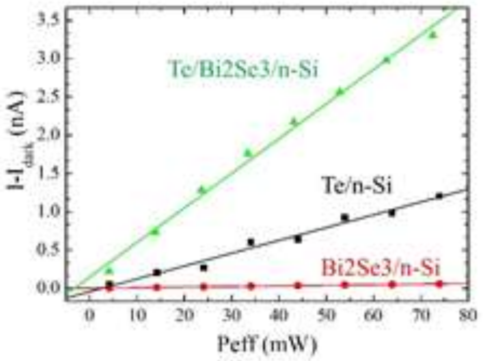

Fig. 1 Photocurrent vs. laser power for Te/Bi2Se3/n-Si (green), Te/n/Si (dark) and Bi2Se3/n-Si) red Photodetectors. The gain of Te/Bi2Se3/n-Si with repect to the Bi2Se3/n-Si is about 60

References

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