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Room Temperature Sensitive Broadband Terahertz Photo Response Using Platinum Telluride Based Devices

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Abstract : The Terahertz (THz) technology-based devices are heightening at an alarming rate on account of the wide range of applications in imaging, security, communication, and spectroscopic field. The various available room operational THz detectors, including Golay cell, pyroelectric detector, field-effect transistors, and photoconductive antennas, have some limitations such as narrow-band response, slow response speed, transit time limits, and complex fabrication process. There is an urgent demand to explore new materials and device structures to accomplish efficient THz detection systems. Recently, TMDs including topological semimetals and topological insulators such as $PtSe_2$, $MoTe_2$, WSe_2, and $PtTe_2$ provide novel feasibility for photonic and optical devices. The peculiar properties of these materials, such as Dirac cone, fermions presence, nonlinear optical response, high conductivity, and ambient stability, make them worthy for the development of the THz devices. Here, the platinum telluride ($PtTe_2$) based devices have been demonstrated for THz detection in the frequency range of 0.1-1 THz. The $PtTe_2$ is synthesized by direct selenization of the sputtered platinum film on the high-resistivity silicon substrate by using the chemical vapor deposition (CVD) method. The Raman spectra, XRD, and XPS spectra confirm the formation of the thin $PtTe_2$ film. The $PtTe_2$ channel length is 5µm and it is connected with a bow-tie antenna for strong THz electric field confinement in the channel. The characterization of the devices has been carried out in a wide frequency range from 0.1-1 THz. The induced THz photocurrent is measured by using lock-in-amplifier after preamplifier. The maximum responsivity is achieved up to 1 A/W under self-biased mode. Further, this responsivity has been increased by applying biasing voltage. This photo response corresponds to low energy THz photons is mainly due to the photo galvanic effect in $PtTe_2$. The DC current is induced along the $PtTe_2$ channel, which is directly proportional to the amplitude of the incident THz electric field. Thus, these new topological semimetal materials provide new pathways for sensitive detection and sensing applications in the THz domain.

Keywords : terahertz, detector, responsivity, topological-semimetals
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