OPTICAL PUMP – TERAHERTZ PROBE FOR TERAHERTZ PHOTOCONDUCTIVITY RESEARCH OF 4H-SIC CRYSTALS*

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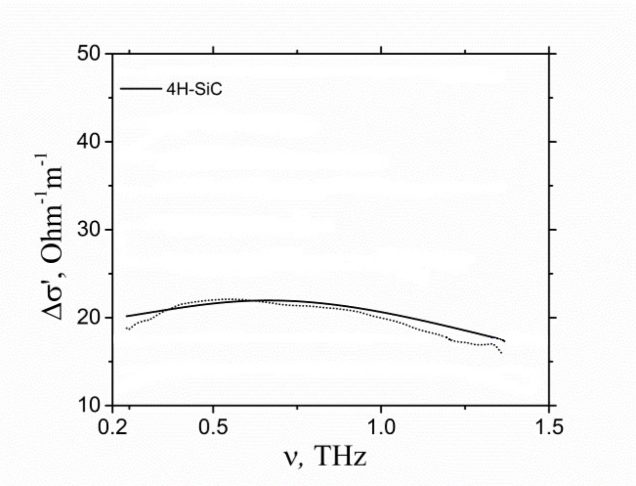
High resolution semiconductor X-ray detectors based on SiC [1, 2, 3] are promising for use in high temperature and high radiation environments, where conventional semiconductor detectors cannot operate. These detectors are expected to be compact, lightweight and capable of long periods of stable operation at room temperature, due to the unique properties of the SiC material. 4H-SiC has the widest bandgap among SiC polytypes (3.23 eV at T=300 K). It is also promising for detectors of ionizing radiation and high-energy particles, due to its high radiation resistance combined with relatively high electron mobility (on the order of ~ 1000 $cm^2/V{\bullet}s$) and long charge carrier lifetime.

Therefore, non-contact methods for monitoring the mobility and lifetime of charge carriers at different injection levels are promising. One such technique is terahertz pump–probe spectroscopy. In our previous work, this technique was used to study another material for detectors of ionizing radiation and high-energy particles - HR GaAs:Cr [4]. In this work, studies of photoconductivity and charge carrier recombination dynamics were carried out using the terahertz pump-probe spectroscopy method. The object of study was 4H-SiC (Eg=3.23 eV at 300 K), femtosecond laser pulses λ=800 nm (photon energy 1.55 eV) were used for photoexcitation.



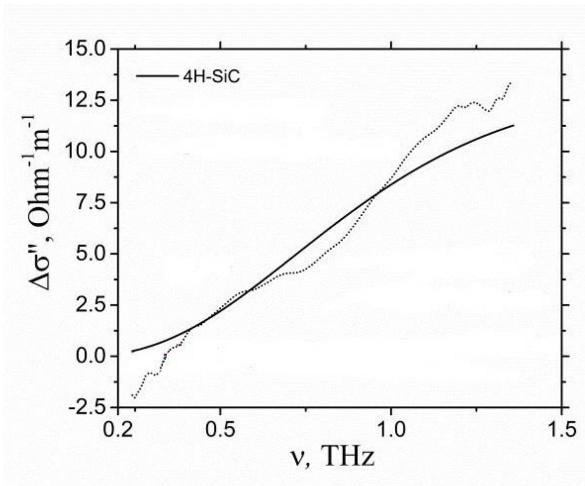


Fig.1. The terahertz spectra of complex conductivity measured 4H-SiC crystals at delays Δt_1 after photoexcitation. Symbols – experimental data, solid lines – Drude-Smith fitting.

REFERENCES

[1] K. C. Mandal , R. Krishna, P. G. Muzykov, Z. Laney, S. Das, T. S. Sudarshan, "Radiation Detectors Based on 4H Semi-Insulating Silicon Carbide", Proc. SPIE 7805, Hard X-Ray, Gamma-Ray, and Neutron Detector Physics XII, Sept. 2010, doi: 10.1117/12.863572.

[2] K. C. Mandal , R. Krishna, P. G. Muzykov, S. Das, T. S. Sudarshan, "Characterization of Semi-Insulating 4H Silicon Carbide for Radiation Detectors", IEEE Transactions of Nuclear Sience, vol. 58, no. 4, pp. 1992–1999, Sept. 2011, doi: 10.1109/TNS.2011.2152857.

[3] G. Bertuccio, D. Puglisi, A. Pullia, C. Lanzieri ,"X-γ Ray Spectroscopy With Semi-Insulating 4H-Silicon Carbide", IEEE Transactions of Nuclear Sience, vol. 60, no 2, pp. 1436-1441, Apr. 2013, doi: 10.1109/TNS.2013.2252019.

[4] I. A. Kolesnikova, D. A. Kobtsev, R. A. Redkin V. I. Voevodin, A. V. Tyazhev, O. P. Tolbanov, Yu. S. Sarkisov, S. Yu. Sarkisov and V. V. Atuchin , "Optical pump–terahertz probe study of HR GaAs:Cr and SI GaAs:El2 structures with long charge carrier lifetimes", Photonics, vol. 8, no. 12, pp. 575_1-11, Dec. 2021, doi: 10.3390/photonics8120575.

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