Tuning properties of TaAs with ionic liquid gating

M. Polakowski[1], Z. Ogorzałek-Sory[1], J. Z. Domagała[2], W. Zajkowska[2], S. Kret[2], J. Binder[1], J. Sadowski[1,2,3], W. Pacuski[1], M. A. Borysiewicz[4], D. Wasik[1] C.-C. Lee[5], H. Lin[5] and M. Gryglas-Borysiewicz[1]

[1] *Faculty of Physics, University of Warsaw, Pasteura 5, Warsaw, Poland,*
[2] *Institute of Physics, Polish Academy of Sciences, Al. Lotników 32/46, Warsaw, Poland,*
[3] *Ensemble3 Centre of Excellence, Wólczyńska 133, 01-919 Warsaw, Poland,*
[4] *Łukasiewicz Research Network - Institute of Microelectronics and Photonics, Al. Lotników 32/46, Warsaw, Poland,*
[5] *Department of Physics, Tamkang University, Tamsui, New Taipei 251301, Taiwan*

Tantalum Arsenide (TaAs) is the first theoretically proposed and then experimentally observed Weyl semimetal [1,2,3]. In Weyl semimetals the bands touch in special points called the Weyl nodes, which have a linear $E(\mathbf{k})$ dispersion and opposite chirality. This gives rise to exotic transport phenomena such like chiral anomaly, large negative magnetoresistance and planar Hall effect [4], observed in bulk samples. However, up to now, no demonstration of topological properties of TaAs grown by the MBE was made. As shown by Ogorzałek [5], this is due to an infavorable position of Fermi level being too far from the Weyl nodes in the energy scale. Thus, there is an ongoing attempt to bring this level closer to the Weyl points.

To this end, we make use of the ionic liquids (ILs), which provide a novel method of manipulating structural, transport, magnetic and optical properties of various materials. Made of charged particles in the liquid state, one of their main application in solid-state physics is gating in field-effect transistors (FET) [6]. When IL is placed between the sample and a gate, voltage applied to the gate forces ions in the IL to rearrange and attract carriers in the sample to the surface, effectively resulting in changing carrier concentration.

In this work, we experiment with various ILs to obtain a carrier concentration change in thin TaAs samples. Thin films of TaAs, grown by the MBE method on GaAs semiinsulating substrates, were formed into large hallbars with silver epoxy contacts. Transport properties, e.g. resistivity and carrier concentration are studied upon IL gating. The role of chemical and electrostatic influence is discussed.

[1] S.-M. Huang et al., *Nat. Commun.* **6** (2015)
[2] S.-Y. Xu et al., *Science* **349** 613-617 (2015)
[3] B.Q. Lv et al., *Nature Physics* **11** 724-727 (2015)
[4] Q.R. Zhang et al., *Phys. Rev. B* **100** 115138 (2019)
[5] Z. Ogorzałek, PhD thesis and publication, in preparation
[6] Y. Guan et al., *Annu. Rev. Mater. Res.* **53** 25-52 (2023)