E-beam lithography as a tool for fabrication of electrical contacts to nanoobjects

Jakub Polaczyński [1], **Tomasz Wojciechowski** [1], **Piotr Dziawa** [2], **Janusz Sadowski** [3,2], **Tomasz Story** [2], **and Tomasz Wojtowicz** [1]

[1] *International Research Centre MagTop, Institute of Physics, Polish Academy of Sciences, aleja Lotników 32/46, PL-02668 Warsaw, Poland*
[2] *Institute of Physics, Polish Academy of Sciences, aleja Lotników 32/46, PL-02668 Warsaw, Poland*
[3] *Department of Physics and Electrical Engineering, Linnaeus University, SE-391 82 Kalmar, Sweden*

Electrical transport studies of nanoobjects, especially nanowires (NWs), have enabled a large number of new findings in both fundamental and applied science. One can mention discovery of Majorana zero modes (MZM) in InSb NWs coupled to a superconductor [1] and photosensing capabilities of GaN-based NWs [2] as examples of the former and the latter case, respectively. One of limiting factors in this research is a fabrication of good electrical contacts to single nanoobjects, which is usually done by means of electron-beam lithography (EBL), metal deposition and lift-off.

Our current activities involve MBE growth [3] and fabrication of electrical contacts to NWs and nanoplates (NPs) of topological crystalline insulators (TCIs), namely $Pb_{1-x}Sn_x(Te, Se)$. Our goal is magnetotransport studies of single nanoobjects, and eventually coupling them to a superconductor. This type of studies has already revealed the presence of surface states in TCI nanostructures grown by chemical vapor deposition (CVD) [4]. However, to the best of our knowledge, no hybrid TCI nanostructure-superconductor devices were reported up to date.

Nanostructures that we produced have dimensions below 2 μm, and therefore fabrication of contacts in 4-probe geometry becomes challenging. Here, we will present main aspects of EBL. The influence of various parameters, such as electrons dose, type of resist and substrate used, will be discussed. We will also show our approach for precise determination of the position of selected NWs or NPs, which involves a use of home-made chips with contact pads and a grid of metallic markers. Since for the electron beam writing of small objects a proximity effect becomes important, we will present the results of proximity effect corrections obtained by NanoPECS software. We will also present examples of MBE-grown nanostructures and nanodevices based on those nanostructures, fabricated by EBL.

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