Nanoprobe-based electrical characterization of semiconductors nanostructures

Stanislav Tiagulskyi[1], Roman Yatskiv[1], Ondřej Černohorský[1], Nikola Bašinová[1], Šárka Kučerová[1], Jan Vaniš[1], Anna Reszka[2] and Jan Grym[1]

[1]*Institute of Photonics and Electronics of the Czech Academy of Sciences, Chaberská 57, Prague, 18200, Czech Republic*
[2]*Institute of Physics, Polish Academy of Sciences, Aleja Lotnikow 32/46, PL-02668 Warsaw, Poland*

The miniaturisation of electronic components is running its natural course during the development of the modern electronic industry. Moving to the nanoscale requires specific methods of investigation since macroscale properties of semiconductor materials could not be directly extrapolated to the nanoscale. Here, we present a method of electrical characterisation on the nanoscale that overcomes the drawbacks of conventional characterisation techniques and helps shed light on the fundamental properties of nanoscale semiconductor structures and nanostructured materials.

To study the electrical properties of the nanostructures, we use two nanomanipulators mounted in the chamber of a multifunctional scanning electron microscope (SEM) that is additionally equipped with the focused ion beam (FIB) and the gas injection system (GIS). The FIB and GIS are used for ion beam milling and local deposition of Pt conductive layers with the aim of building more complex nanoscale structures without additional steps (transfer to other substrates, lithographic deposition of contacts, etc.). The manipulators in SEM allow us to measure the current-voltage characteristic of a single nanostructure with desirable morphology controlled by SEM imaging simultaneously with electrical characteriation. Moreover, the vacuum chamber reduces the impact of gas adsorption and light irradiation, which both affect the properties of structures under the test.

We demonstrate examples of the implementation of the nanoprobe-based approach for the electrical characterisation of ZnO/GaN single nanorod heterostructures [1,2], GaN/AlGaN nano-LEDs [3], patterned graphene/ZnO [4] and graphene/Ga_2O_3 interfaces, nanoscale ZnO nanorod/graphene Schottky diodes [5], and single nanowire metal/semiconductor/metal structures [6].

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