Terahertz emission from semiconductor nanowires and non-stoichiometric layers: similarities and differences

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Recently, low-dimensional semiconductor nanomaterials have attracted great attention due to their potential for infrared optoelectronics and photovoltaic applications. Also it has been reported that various nanostructures in comparison with bulk semiconductors are able to enhance terahertz (THz) emission from optically excited surfaces. This radiation is determined by the photo-excited electric dipoles which orientation is essential for an efficiency of THz emission. In this work we applied novel measurement techniques for investigation of radiating dipoles in two kinds of semiconductor nanostructures.

In present work, THz emission from molecular beam epitaxy grown Ga-rich GaAs layers and tilted semiconductor nanowires (NWs) was investigated. Experiments were performed using Ti:sapphire oscillator and low temperature grown GaAs antenna for THz electric field detection. THz pulse amplitude dependencies on an angle between the incident laser beam and a normal to the sample surface as well as THz emission azimuthal dependencies in transmission and reflection geometries were performed. We found that in our samples exist two types of THz radiating dipoles. Perpendicular to the semiconductor surface electric dipole is typical for GaAs substrate, whereas parallel dipole occurs due to excess Ga unevenly distribution in non-stoichiometric GaAs layer. In contrast the origin of electric dipole in tilted semiconductor NWs is photoexcited carriers moving along the NW. In this case we have parallel and perpendicular components of the same electric dipole. In tilted NW and some non-stoichiometric GaAs structures parallel to surface dipole is non-vanishing and significant at every sample orientation, whereas in other structures the influence of this dipole depends on azimuthal and excitation angles. Our investigation showed that parallel to the surface electric dipole enhances THz emission and changes intensity ration between reflection and transmission THz beam modes.

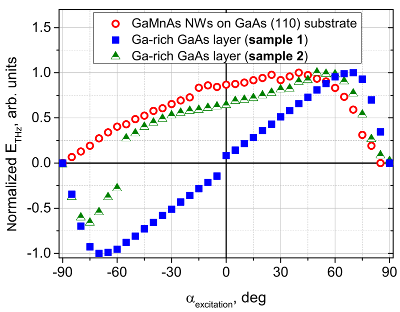

Figure 1: THz pulse amplitude dependencies on an angle between the incident laser beam and a normal to the sample surface for the removed GaMnAs nanowires (NWs) layer and two Ga-rich GaAs layers.

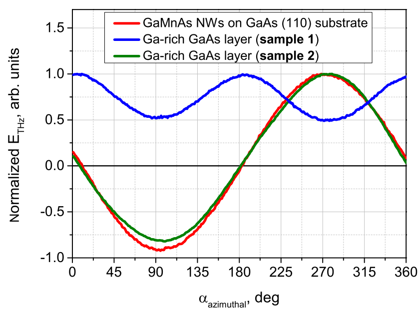

Figure 2: THz emission azimuthal dependencies of the removed GaMnAs NWs layer and two Ga-rich GaAs layer.