AlGaN/GaN heterostructures for plasma wave instabilities in THz regime

Irmantas Kašalynas[1] and Maciej Sakowicz[2]
[1]Center for physical sciences and technology, CPST, Vilnius, Lithuania
[2]Institute of High Pressure Physics Polish Academy of Sciences, UNIPRESS, Warsaw, Poland
irmantas.kašalynas@ftmc.lt

At the beginning of 90's Dyakonov and Shur proposed plasma excitations in nanometer field effect transistors for THz detection and emission [1, 2]. They have shown that the channel of a field effect transistor (FET) can act as a resonator for plasma waves with a typical wave velocity s ~ 10^8 cm/s. The fundamental frequency *f* of this resonator depends on its dimensions and for gate length *L* of a micron or less, can reach the terahertz (THz) range, since *f* ~ s/L. Dyakonov and Shur [1, 2] predicted also that a steady current flow in an asymmetric FET channel can lead to instability against the spontaneous generation of plasma waves. This can in turn produce the emission of electromagnetic waves in THz regime.

Nanometer semiconductor structures may serve as resonators for plasma excitations (plasma waves) and can reach the THz range. Group of prof. W. Knap confirmed experimentally theoretical predictions on THz emission and detection [3]. However all observed resonant phenomena were much broader than theoretically predicted. Also in many cases the observed emission was not resonant and not voltage tunable [4].

Polish-Lithuanian Funding Initiative DAINA based project „*Terahertz Plasma Wave Instabilities in GaN/AlGaN Nanowires*“ aims to solve three problems which limit plasma wave instabilities generation in AlGaN/GaN high-electron-mobility transistor (HEMT) structures: (i) Coexistence of concurrent oblique modes; (ii) Shallow impurities emission; (iii) Blackbody radiation caused by Joule heating of biased HEMT channels. In this work we proposed the solutions based on new designs of narrow channel (nanowire) HEMT, an original control of the residual impurities via THz electroluminescence spectroscopy, and a specific cooling of the plasmonic channels and reduction of the BB radiation of GaN/AlGaN HEMT structures grown on SiC substrate [5-8].

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