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Towards on-chip plasmonics amplifiers of THz radiation – ERC – advanced project

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One of the major nowadays scientific challenges lying at the border between physics and electronics, is to find solid state systems that can amplify and generate terahertz frequencies. Around 30 years ago, a new direction in solid state physics and electronics opened with the arrival of plasma-wave electronics. M. Dyakonov and M. Shur theoretically predicted that THz radiation can be rectified/detected by plasma nonlinearities and the current in the nanometer field-effect transistors could lead to the excitation of plasma oscillations. The detection part of the "plasmonics promise" was proven and nowadays THz plasmonic detectors arrays are widely used. In the case of emitters, the task appeared much more complicated.

Only very recently, room temperature, current driven amplification of the incoming THz radiation in graphene grating gate structures with an innovative double grating gate geometry has been shown [1]. These results indicate that, existing model of plasmonic systems should be reconsidered and that use of the new 2D materials or their heterojunctions with semiconductors, once processed with innovative geometries may lead "Towards on-chip plasmonics amplifiers of THz radiation".

Therefore the ground-breaking objectives of the recently awarded ERC ADVANCED TERAPLASM that will be realized in CENTERA LABS (IHHP PAN 2023-2028) are : i) to understand the physics of the observed THz plasmonic amplification in graphene devices ii) investigate properties of new plasmoic 2D systems like GaN/AlGaN, Hg/HgCdTe and ii) reexamine all existing THz plasmonic amplification mechanisms/theories considering new/ innovative geometries.

By extensive technological, spectroscopic and theoretical research TERAPLASM project will tend to answer 30 years old basic physics and electronics question, about the possibility of realization of on-chip plasmonics amplifiers of THz radiation, important also for society through potential applications of THz radiation in biosensing, security screening as well as for fast wireless telecommunication.

REFERENCES

[1] Stephane Boubanga-Tombet, Wojciech Knap, Deepika Yadav, Akira Satou, Dmytro B. But, Vyacheslav V. Popov, Ilya V. Gorbenko, Valentin Kachorovskii, and Taiichi Otsuji Room, Temperature Amplification of Terahertz Radiation by Grating-Gate Graphene Structures, Phys. Rev. X 10, 031004 (2020)