Cacomel - Nano-carbon based components and materials for high frequency electronics

Referente: Prof. Giovanni Miano - Dipartimento di Ingegneria Elettrica

Project summary

A strong expansion of the frequency range towards terahertz and infrared is the major trend in the modern electronics and optoelectronics. It relies on the incorporation of modern nanotechnology that has already given the birth to nanoelectronics, a rapidly developing discipline focused on both the dramatic increase of the component integration level and decrease in a power consumption. Performance of nanoelectronic devices is strongly influenced by quantum effects that often even determine properties of nano-sized components. The project aims at understanding of fundamentals of the electromagnetic processes in nanocircuits, theoretical and experimental investigation of underlying mechanisms responsible for their fascinating properties, and development of physical basis for use of these properties in novel nanoelectronic devices. The project focuses on resolving the problem of implementation of CNTs into nanoelectronics, and fabrication of nonlinear devices in fibers and waveguides for signal processing, all-optical switching, etc. The project has the following main objectives:

− to reveal the effects of spatial irregularities in the performance of CNT-based components and nanocircuits;

− to develop EMC theory of the circuits with nano-sized components;

− to perform experimental and theoretical investigation of high frequency and nonlinear optical properties of nano-carbon materials as potential materials for electromagnetic shielding and optical application.

Linear and nonlinear electromagnetic effects in nano-carbon structures, such as onion-like carbon and both single- and multi-wall carbon nanotubes, will be studied. Detail consideration to the performance of nanocircuits based on carbon nanotubes and other nanocarbon materials will be carried out, and fundamentals of the EMC theory as applied to circuits with nano-sized components will be developed. The role of intertube tunnelling in the performance of CNT-based high-frequency circuits will be studied. the second- and third order nonlinear optical effects in CNTs and other sp2 nanocarbons to reveal their performance in nonlinear optical devices will be investigated. Different aspects of the design of materials based on sp2-nanocarbons for photonics and optoelectronics will be considered and the study of electromagnetic response of novel nano-carbon based composites to microwaves, THz, IR and optical frequencies will be undertaken in order to clarify their possible use for electromagnetic coating/shielding for a wide spectrum of technological applications.

The proposed multi-disciplinary research joins in a complimentary way differently experienced teams: electromagnetic theory and nanoelectromagnetism, solid state physics and quantum chemistry, characterization and optical spectroscopy of nano-carbons and nanocarbon materials, and nano-carbon fabrication technology. The composition of the research consortium provides for both successful realization of the project objectives and intensive knowledge exchange between teams. The challenging project relies on the complementary expertise of the consortium teams and is based on the original approach combining electrodynamics of mesoscopic inhomogeneous media and quantum theory of electronic ensembles with reduced dimensionality.

Coordinator: Technische Universität Berlin, Institut für Festkörperphysik

Other participants:

- University of Joensuu - Finland
- Università degli Studi di Napoli Federico II - Italy
- University of Latvia, Institute of Solid State Physics - Latvia
- Belarus State University, Institute for Nuclear Problems - Belarus
- A.M. Prokhorov General Physics Institute of Russian Academy of Sciences - Russia
- Kurnakov Institute of General and Inorganic Chemistry, Russian Academy of Sciences Russia

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