PAP Seminar Announcement

Optical Integrated Circuits based on Exciton-Polaritons

By

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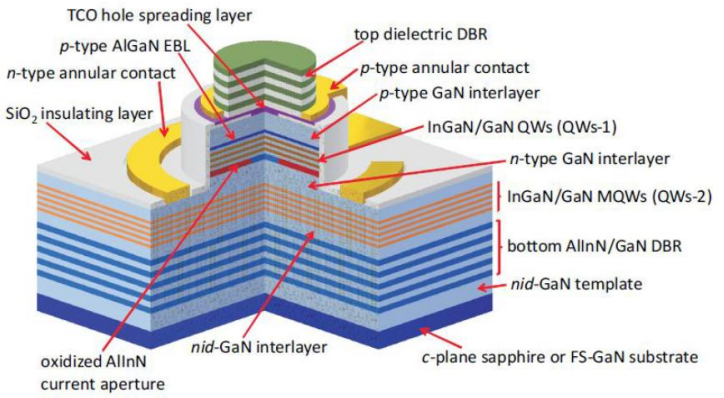
Host: Asst. Prof. Cesare Soci & Assoc. Prof. Ivan Shelyk

Abstract

Exciton-polaritons are mixed light-matter quasiparticles combining properties of photons and excitons. The Bose-Einstein condensation of exciton-polaritons results in a spontaneous emission of a coherent light, or polariton lasing. Polariton lasers with optical pumping have been realized in GaAs, CdTe and GaN based planar and pillar microcavities. They represent the first class of opto-electronic devices based on exciton-polaritons and possess unique characteristics including the ultra-low threshold power, controllable polarization of emission, peculiar statistics of emitted photons . So far only optically pumped polariton lasers have been realized while very detailed proposals on the design of electrically pumped polariton lasers have been published (figure).



Several other types of polariton devices are being developed. Experimentally, GaAs-microcavity based electrically pumped polariton diodes , optical parametric oscillators , optical switches and optical logic gates have been already realized. The theoretical proposals go farther evoking the possibility of building of all-optical integrated circuits based on polariton neurons . These devices would exploit giant optical non-linearities induced by polariton condensates: the optical bi-stability or multi-stability appearing due to these resonant non-linear effect allows for formation of domains of high polariton concentration. These domains may be spin-polarised. The information transfer in polariton neurons is due to the ultrafast motion of the domain walls.

In this talk I will review the progress in the development of polariton-based optical integrated circuits and address the role of Tamm plasmons (zero-wave-vector plasmon modes in microcavities covered by metal) in their realization.

Short Biography

Prof Alexey Kavokin is a theoretical physicist deeply involved in international collaborations over the Globe and in coordination of the international research effort in physics of light-matter coupling. His major research contributions include the theory of polariton lasers, theory of spin superfluidity, predictions of the optical spin Hall and spin Meissner effects further observed experimentally, works on polariton logic gates and spin switches, photonic Bloch oscillations, exciton supersolidity. In 1998 he has become the youngest university professor in France. Since 2000 he chairs the sequence of European research training networks “Exciton-polaritons: physics and applications”, the last one uniting 14 laboratories and having a budget of 4.3 M€. He has been a PI on over 10 European, UK, French and Russian grants. he has founded the series of international conferences on Physics of Light-Matter Coupling in Nanostructures and International Schools on Nanophotonics which are organized on a yearly basis since 2000. In 2010 he has founded the Mediterranean Institute of Fundamental Physics, a research association which has 130 academic Members at present. In 2011 he have been awarded by a “Megagrant” of the Government of Russian Federation for creation of Spin Optics laboratory at the State University of St-Petersburg. At present he is a Head of this laboratory having 30 staff members.

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