

2nd International Conference and Exhibition on **Lasers, Optics & Photonics** September 08-10, 2014 Hilton Philadelphia Airport, USA

Quantum cascade lasers in bio-medical applications: The reality check

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All disease states, without exception, are caused by fundamental changes in tissue biochemistry. The diagnostic potential of infrared spectroscopy is based on the fundamental premise that in any pathologic process, the chemical change must precede the morphological or symptomatic manifestation, thus allowing spectroscopic diagnosis at an earlier stage of the disease. Mid-IR spectral range where “fingerprint” absorption is due to the fundamental vibrations of molecules can detect targeted molecules in complex biological systems with high sensitivity and specificity. Ultra-sensitive chemical analysis based on molecular absorption in the mid-IR region is a well-established approach. A number of techniques have been developed to measure absorption coefficients as low as 10^{-9} cm^{-1} , allowing, in some cases, for the quantification of chemical species at part per trillion by volume concentration levels. Despite high expectations the mid-IR methods did not enter the mainstream of medical practice. It appeared that the lack of instrumentation was to blame: Fourier Transform Spectrometers were limited in their performance, while free-electron lasers and synchrotron beams were too rare and expensive. The development of Quantum Cascade Lasers promised finally to put mid-IR into the frontline of modern diagnostic, disease research and drug discovery. The presentation will review the state of the art in Mid-IR laser technologies for bio-medical applications, discuss challenges and limitations.

Biography

Igor E Trofimov, PhD, is a Founder and CEO of Princeton Technology Advisers Company. He has been involved in all aspects of development of complex analytical equipments, from fundamental research in physics, to development and manufacturing of semiconductor optoelectronic devices and precision spectroscopic equipments. He is a Founder and Chairman of AKELA Laser Corporation—a specialty semiconductor laser manufacturer that was spun out of PTAC in 2003. He is a member of NSF-ECR MIRTHER Industrial Advisory Board; he consulted Becton Dickinson and Company, Applied Optonics, Raytheon, Northrop Grumman and TRUMPF Photonics in their product development. He received BSc in Physics and MSc in Physics and Electrical Engineering from Moscow Institute of Physics and Technology, and PhD in Semiconductor Physics from the USSR Academy of Sciences. He has co-authored over 40 publications and three patents. He is the editor of the first comprehensive book on “Quantum Cascade Lasers and their Applications” to be published in 2014.

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