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Non-fluorescent and fluorescent optical microscopy with 100 nm resolution

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Abstract

Fluorescent super-resolution microscopy got tremendous development in last decade, but it is not applicable to non-fluorescent objects that are abundant in biological and inorganic worlds. We developed novel structured illumination microscopy (SIM) system that allows imaging of both non-fluorescent and fluorescent objects with sub-diffraction lateral resolution of 100 nm. Complex biological objects often contain both non-fluorescent and fluorescent parts, making the dual mode (fluorescent and in scattered light) microscopy highly informative.

We designed and built the computer controlled structured illuminator based on the digital micro- mirror device and using incoherent white light source. Attached to commercial inverted microscope, the illuminator allows unified recording and reconstruction of SIM image in both scattered and fluorescent light modes.

Super-resolution microscopy with the lateral resolution of about 100 nm was demonstrated for a variety of non-fluorescent and fluorescent objects. Inorganic non-fluorescent objects included silicon microchip, and single and aggregated gold nanoparticles. In bacterial non-fluorescent samples super-resolution was demonstrated for scanning electron microscopy sample on the grid and standard microbiological microscopic slides. For fluorescently labeled cells in cancer HeLa cell F-actin fibers and mitochondrion were imaged in two colors. Combined scattered light and fluorescent dual mode images were recorded for non-fluorescent gold nanoparticle inside the HeLa cell with fluorescent dye labeled cytoskeleton.

Biography

Arnold Vainrub's current research interests are in the areas of super-resolution optical imaging and DNA aptamer arrays. He serves as Scientist in Center for Biomedical Engineering and Associate Professor in Department of Ophthalmology and Visual Sciences at the University of Texas Medical Branch. Previously he worked for Auburn University, University of Houston and Ecole Polytechnique (France) and consulted for Mitsubushi Rayon and ICI. Dr. Vainrub published over 40 articles and three book chapters on DNA microarrays, optics, superconductors, sol-gel technology, NMR, and scientific instrumentation. He holds two US patents. Dr. Vainrub completed his PhD studies in physics in Ioffe Physical-Technical Institute, St-Petersburg, Russia.