

**SPIE SHORT COURSE:**

## **Combination of Photonics Tools with Nanostructured Particles for Biomedical Applications**



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The photonic tools can be used for *in vivo* navigation, visualization and activation of new type of multifunctional nanostructured particles. These particles will combine ability to deploy drug in controllable manner with physical triggering, multimodal detection and visualization as well as sensing of important biological markers. It was required to apply a new bottom-up method as layer by layer assembly and freezing induced loading and their combination. It can be allowed us to vary of the volume fraction of components and its chemical composition led to the control the physicochemical and mechanical properties of multifunctional carriers. Physical targeting of carriers was realized by gradient of magnetic field, optical tweezers approach. Acoustics has a good perspective for same purpose. The carrier sensitivity to external influences as laser irradiation, ultrasound treatment can be changed by variation of volume fraction and chemical composition of inorganic nanoparticles and/or organic dyes in the carrier shells. Same approach is applied for drug delivery carriers imaging by MRI, OCT and optoacoustics using inorganic nanoparticles and/or organic dyes as contrast or functional agents. Combination of photonic tools with multifunctional carriers has a good perspective for application in biomedicine for diagnostic and therapy.

This short course will review the methods for nanostructured particles preparation and photonic and acoustic tools that can be used for their visualization, navigation and remote-controlled release of bioactive substances. The application of hollow-core microstructured optical fibers for sensing, imaging and drug delivery will be also discussed. The parts of course are:

1. Methods for preparation nanostructured drug delivery carriers as well as approach for effective loading of these carriers by bioactive substances. There are Layer by Layer assembly and Freezing Induced Loading methods and their combination for preparation of multifunctional particles with tunable physical properties;
2. Application of photonic and acoustic tools for visualization, navigation of multimodal and multifunctional carriers and remote-controlled release of bioactive substances;
3. Microstructure optical waveguide-based endoscopic probes for sensing and detection as well as drug delivery system for intraoperative applications.

### **Learning objectives**

This course will provide the new knowledge about approaches for preparation of new type of drug delivery carriers that will combine functions of *in vivo* navigation and visualization, ability to deploy drug in controllable manner, including external triggering and sensing of important biological markers.

The course will provide the participants with:

- ➔ Method for preparation of nanostructured drug delivery carriers as well as approach for effective loading of these carriers by bioactive substances;
- ➔ Examples of application of photonic and acoustic tools for visualization, navigation multimodal and multifunctional carriers and remote-controlled release of bioactive substances;
- ➔ Methods of microstructure optical waveguide (MOW) modification for following sensing application. Review of minimally invasive optoacoustic imaging and detection.

### **Intended Audience**

Undergraduate, Masters, and PhD students, post-doctoral trainees and research scientists in physical sciences and material sciences with an interest in biophysics and biophotonics.

### **Course level**

Intermediate

### **Course Duration**

two one-hour lectures

### **Instructor**

Dmitry Gorin is a Professor at the Center of Photonics & Quantum Materials at Skolkovo Institute of Science and Technology (Moscow, Russia). He has received Diploma of Engineer-Physicist in 1997 and his CSc, and DSc degrees in Physical Chemistry in 2001 and 2011 from Saratov State University, respectively. From 2005 till 2009 he has visited Max-Planck Institute of Colloids and

Interfaces (Potsdam, Germany). He was a PostDoc fellow in the Max Planck Institute of Colloids and Interfaces (group headed by Prof. Dr. H. Moehwald) from 2009 till 2010. He was Professor at Department of Nano- and Biomedical Technologies at Saratov State University from 07.2011 till 08. 2017. Since 2017 he has been working at Skolkovo Institute of Science and Technology. He is author and co-author of 145 articles in peer-reviewed journals (Web of Science), 1 book and 6 book chapters and 8 tutorials for students and PhD students, and co-inventor of 20 patents. He was promoter of 11 completed PhD theses (Candidate of Science) and 2 Habilitation theses (Doctor of Science). Research interests of Prof. Gorin are in Biophysics, Biophotonics, Theranostics, Physics and Chemistry of Colloids and Interfaces.