ROMA TRE UNIVERSITÀ DEGLI STUDI Dipartimento di Ingegneria iNGEGNERIA DIPARTIMENTO DI ECCELLENZA

IEEE photonics SOCIETY ITALY CHAPTER

Imaging Biological Species and Advanced Materials at Sub-diffraction Resolutions with Apertureless Scanning Near-field Optical Microscopy

Stefan G. Stanciu

Center for Microscopy-Microanalysis and Information Processing
University Politehnica of Bucharest

27 gennaio 2020 ore 14.00 aula multimediale

Abstract

The scientific communities working in optics and photonics have placed massive efforts over the past couple of decades for developing imaging techniques capable of optical resolutions surpassing the diffraction barrier. Among these, scanning-probe techniques that exploit the interaction of a laser beam and a sharp tip for optically probing an investigated sample hold huge potential for the nanoscale characterization of advanced materials, as they don't require sample labeling. Such techniques, known as Apertureless Scanning Near-Field Optical Microscopies (ASNOM) make possible resolutions down to 1nm, depending solely on the size of the sharp tip used for scanning, independent of the illumination wavelength (visible, IR, ThZ regimes). Considering the valuable contrast mechanisms of ASNOM techniques, and their capability for label-free imaging at nanoscale, it is expected that they will play a crucial role in the coming years for advancing our current understanding of the structural, chemical and optical features of advanced materials and biological samples. However, at this time the penetration of ASNOM modalities in the above-mentioned domains is still biased by data interpretation, which is not always straightforward. To alleviate this problem, we have recently developed a multimodal imaging system capable to collect optical data sets on overlapping field-of-views by several ASNOM and far-field Laser Scanning Microscopy (LSM) techniques. The contrast mechanisms of the incorporated imaging techniques provide complementary information, which plays an important role in facilitating ASNOM nanoscale data understanding and interpretation [1,2]. In this talk I will mainly focus on the most notorious ASNOM technique (included in this multimodal setup), known as scattering-type Scanning Near-Field Optical Microscopy (s-SNOM). I will discuss its underlying concepts and showcase a series of results collected in our lab on biological specimens and advanced nanostructured materials in both correlative and single-technique assays. The capabilities of s-SNOM to extract information over the real-part and imaginary-part of the dielectric function at spatial resolutions beyond the diffraction barrier [3,4,5] will be highlighted, and augmentation of s-SNOM data analysis by exploiting phasor space representations will also be addressed [6]. Finally, I will share a series of perspectives for extending this architecture with additional work modes, along with related forthcoming applications.

[1] S.G. Stanciu, D.E. Tranca, C. Ruggiero, G.A. Stanciu, A. Antipov, R. Hristu, L. Pastorino, "Combined far-field, near-field and topographic imaging of nano-engineered polyelectrolyte capsules", Mater. Lett. 183, 105-108 (2016)

[2] S.G. Stanciu, D.E. Tranca, R. Hristu and G.A. Stanciu, "Correlative imaging of biological tissues with apertureless scanning near-field optical microscopy and confocal laser scanning microscopy", Biomed. Opt. Express 8, 5374-5383 (2017)

[3] D.E. Tranca, S.G. Stanciu**,** R. Hristu, C. Stoichita, S.A.M. Tofail, G.A. Stanciu, "High-resolution quantitative determination of dielectric function by using scattering scanning near-field optical microscopy", Sci. Rep. 5, 11876 (2015)

[4] D.E. Tranca, S.G. Stanciu**,** R. Hristu, B.M. Witgen, and G.A. Stanciu, "Nanoscale mapping of refractive index by using scattering-type scanning near-field optical microscopy", Nanomedicine: Nanotechonolgy Biology Medicine 14, 47-50 (2018)

[5] S.G. Stanciu, D.E. Tranca, L .Pastorino, S. Boi, Y.M. Song, Y.J. Yoo; S. Ishii; R. Hristu; F. Yang, G. Busetti, G.A. Stanciu, "Characterization of Nanomaterials by Locally Determining their Complex Permittivity with Scattering-Type Scanning Near Field Optical Microscopy", *ACS Applied Nano Materials, (2020) in press*

[6] D.E. Tranca, S.G. Stanciu, L. Latterini, R. Hristu, G.A. Stanciu, Surface optical characterization at nanoscale using phasor representation of data acquired by scattering scanning near-field optical microscopy, *Applied Surface Science*, (2020) in press

Biography

Dr. Stefan G. Stanciu (36-y.o.), is currently conducting his research activities as a Scientific Researcher / Research Project Leader at the Center for Microscopy-Microanalysis and Information Processing of Politehnica University of Bucharest (CMMIP-UPB). His current research agenda focuses on (i) optical characterization of biological species and advanced materials using correlative imaging approaches (ii) development of novel image processing and analysis methods for microscopy/nanoscopy, and (iii) hardware (opto-mechatronics and electronics) developments for high-resolution imaging at micro- and nanoscales. Stefan's doctoral work (2007-2011, UPB) addressed the development of digital image processing and computer vision techniques for enhanced visualization, representation and display of Confocal Scanning Laser Microscopy Data.

Among others, the scientific activities performed to date by Stefan have led to the publications of >45 articles in Web of Science indexed journals (>15 as first or corresponding author). Stefan has gained valuable R&D expertise by participating in more than 25 Research Projects funded by national or European research grants, and currently he is acting as a) Coordinator of two European collaborative projects funded under H2020 ATTRACT's competition for breakthrough technology concepts (HARMOPLUS and TEFPLASNOM), both dealing with optical imaging at sub-diffraction resolutions, b) Director of one research grant (CORIMAG), dealing with correlative imaging at micro and nanoscale, funded by the Romanian Executive Agency for Higher Education, Research, Development and Innovation Funding, c) Partner Leader of one research grant funded by the Guangxi Scientific Research and Technology Development Plan in China, dealing with single molecule imaging, and d) Partner Leader for one research grant focused on the characterization of novel nanobiomaterials implemented in collaboration with the Ningbo Institute of Materials Technology and Engineering, of the Chinese Academy of Sciences.

Stefan is also currently acting as Management Committee Member in two Actions funded by the European Cooperation in Science and Technology (COST) organization: *CA15124 "*A new Network of European BioImage Analysts to advance life science imaging (NEUBIAS, 2016-2020)" and CA16124 « Brillouin Light Scattering Microspectroscopy for Biological and Biomedical Research and Applications (BioBrillouin, 2017-2021)".

Organizzatore
Prof. Gabriella Cincotti