# Raman spectroscopy – translational approaches for routine clinical applications

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Due to an aging society a large increase of cancer is observed. Besides, due to an increasing world-wide mobility a fast spread of infectious diseases and antibiotic resistant pathogens can be observed. For an effective and early diagnosis and personalized therapy of these diseases new methods providing a differential diagnosis are required. In the last years linear and non-linear Raman methods have shown their potential to be in a position to meet these aforementioned challenges.[1,2] In this presentation, we will highlight our recent advances in translating Raman approaches towards routine clinical applications with focus on cancer and infectious diseases, since these types of diseases as mentioned above represent unmet medical needs with respect to diagnosis and therapy. We will start with highlighting the potential of Raman microspectroscopy for an early diagnosis and therapy of infectious diseases with special focus on sepsis. In the field of sepsis, the fast identification of pathogens, their resistances and the specific host is crucial for choosing the appropriate initial antibiotic therapy to save lives in intensive care units. It will be shown that Raman spectroscopy in combination with innovative chemometric strategies and chip-based sampling approaches hold great promise as point-of-care approaches to address these challenging tasks.[3-8] Furthermore, it will be shown that the combination of linear and non-linear Raman approaches with other spectroscopic technologies provides a sensitive and

selective tool to potentially solve challenges currently faced by clinical pathology. We will introduce two different strategies: (I) Fast imaging techniques are combined with slow but specific linear Raman spectroscopy to a large field of view of morphological information with a richness of molecular Raman information of selected points or confined areas. This strategy is realized by a combined Raman / FLIM (fluorescence lifetime imaging microscopy) fiber optical probe for in-vivo tissue screening.[9] (II) Furthermore, non-linear Raman techniques like e.g. CARS (coherent anti-Stokes Raman spectroscopy) are combined with imaging approaches with similar image acquisition times like e.g. two-photon excited autofluorescence (TPEF), second harmonic generation (SHG), FLIM etc. We will particularly introduce a compact CARS/SHG/TPEF multimodal nonlinear microscope in combination with novel fiber laser sources for use in clinics.[10] It will be shown that CARS/TPEF/SHG imaging in combination with advanced image processing algorithms offers great potential to complement established clinical pathological diagnostic tools and to augment standard intraoperative clinical assessment with multimodal images to highlight functional activity and tumor boundaries.[11-15]

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## Short Biography

**Juergen Popp** studied chemistry at the universities of Erlangen and Würzburg. After his PhD in Chemistry he joined Yale University for postdoctoral work. He subsequently returned to Würzburg University where he finished his habilitation in 2002. Since 2002 he holds a chair for Physical Chemistry at the Friedrich-Schiller University Jena. Since 2006 he is also the scientific director of the Leibniz Institute of Photonic Technology, Jena. His research interests are mainly concerned with biophotonics. In particular his expertise in the development and application of innovative Raman techniques for biomedical diagnosis should be emphasized. He has published more than 630 journal papers and has been named as an inventor on 12 patents in the field of spectroscopic instrumentation. He is founding editor and Editor-in-Chief of the Journal of Biophotonics. In 2012, he received an honorary doctoral degree from Babeş-Bolyai University in Cluj-Napoca, Romania. Professor Jürgen Popp is the recipient of the 2013 Robert Kellner Lecture Award and the prestigious 2016 Pittsburgh Spectroscopy Award. In 2016 he was elected to the American Institute for Medical and Biological Engineering (AIMBE) College of Fellows.

## 10 most important publications:


1. Krafft C, Schmitt M. Schie IW, Cialla-May D, Matthaeus C, Bocklitz T, Popp J* (2016) Label-free molecular imaging of biological cells and tissues by linear and non-linear Raman spectroscopic approaches, Angew. Chem. Int. Ed., DOI: 10.1002/anie.201607604R1.

2. Krafft C, Schie IW, Meyer T, Schmitt M, Popp J* (2016) Developments in spontaneous and coherent Raman scattering microscopic imaging for biomedical applications, Chem. Soc. Rev., 45, 1819– 1849.

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