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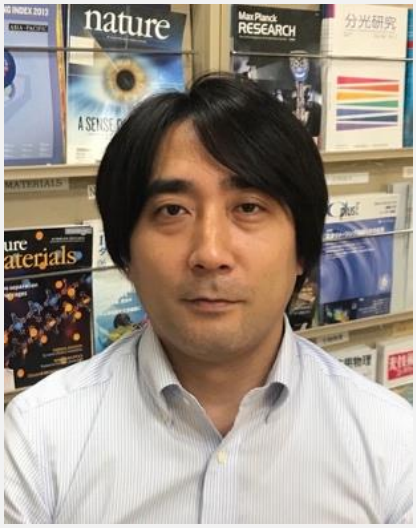
Raman microscopy for imaging intracellular molecules



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Raman spectroscopy has been an attractive tool for scientists because of its capability of label-free analysis of materials. Raman spectra reflect molecular or lattice vibration in a sample and provide rich information about the sample compositions and their environments. However, due to the small cross-section of Raman scattering, it has been difficult to utilize Raman scattering for imaging biological samples under physiological conditions. We have developed Raman imaging techniques that utilize the advantages of spontaneous Raman scattering. The simple optical process of Raman scattering allows us to perform spatial multiplexing of signal detection, which has been enabled by the recent development of high-power lasers and 2D sensors with large pixel numbers. We utilized this advantage to realize high-speed Raman imaging by illuminating a sample by a line-shaped focus [1,2]. The parallel detection of hundreds of Raman spectra from the illumination line drastically shortened the image acquisition time. We applied the line-illumination Raman imaging technique to observe molecular dynamics in cellular events, such as apoptosis, cell division, and cell differentiation [3-5]. The use of laser light at 532 nm for excitation allows us to monitor mitochondrial dysfunction in the subcellular scale via the resonant Raman effect on heme proteins [6]. We also proposed and demonstrated the use of alkyne as a tiny tag for imaging small molecules, which enabled the observation of molecules too small to be labelled by fluorescent probes [7-9].

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SHORT BIOGRAPHY

Katsumasa Fujita is a professor of applied physics at Osaka University. He received his BSc, MSc, and Ph.D. all in applied physics in 1995, 1997, and 2000, respectively, from Osaka University. After working as a JSPS postdoctoral fellow at Kyoto Prefectural University of Medicine and as a research associate at Frontier Research Center in Osaka University, he was appointed as an assistant professor in Osaka University in 2002 and was promoted to a full professor in 2018. His research interest includes optical microscopy, non-linear optics, vibrational spectroscopy and their applications for biomedical sciences. He developed techniques for imaging biological samples using spontaneous Raman scattering. His technique improved the image acquisition speed in Raman microscopy, which allowed us to observe and analyze molecular dynamics during biological events. He also demonstrated the use of alkyne as a small tag for imaging small molecules by using the unique Raman peak of alkyne. His current development is focused on the further improvement of the spatial and temporal resolution of Raman imaging.