A Multimodal Laser-Scanning Microscope Integrating O-PTIR and PT-SRS for High-Speed, Sub-Micron Chemical Imaging

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Abstract

I present a new laser-scanning microscope platform for real-time, label-free vibrational chemical imaging that integrates Optical Photothermal Infrared (O-PTIR) and Photothermal Stimulated Raman Scattering (PT-SRS, also known as Stimulated Raman Photothermal, SRP) within a single multimodal system.

The system employs high-speed synchronized infrared and probe-beam scanning to achieve rapid, large-area chemical mapping, with full hyperspectral datasets acquired in minutes. Three-dimensional, depth-resolved imaging is supported, extending applicability to thick and heterogeneous samples. To accommodate diverse experimental requirements, the instrument supports both co- and counter-propagating beam geometries, enabling measurements on IR-transparent and IR-opaque substrates.

By combining O-PTIR and PT-SRS in one platform, the system provides complementary vibrational contrast mechanisms that enhance chemical specificity and broaden applicability to complex biological and materials samples. Integrated multi-line widefield and (future) laser-scanning confocal fluorescence microscopy further enables fluorescence-guided infrared and Raman acquisition, facilitating correlative workflows in cellular biology, pathology, environmental analysis, and functional materials research.

Representative datasets will be presented, including mixed polymer standards, live-cell lipid dynamics, brain tissue sections, and microplastic mapping. These results demonstrate high-resolution imaging performance together with efficient extended-area analysis.

This multimodal approach establishes a versatile platform for high-speed, chemically specific imaging across biological, environmental, and materials science applications.