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# Fiber-laser-based stimulated Raman scattering microscope in fingerprint region with a Neodymium doped fiber laser at 920 nm

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## 1. Introduction

Stimulated Raman scattering (SRS) microscope is a powerful tool for label-free rapid imaging [1-3]. As a fiber-laser-based SRS (FL-SRS) microscope is promising in terms of compactness, robustness and cost efficiency, several types of FL-SRS microscopes have been studied. For the measurements in the CH stretching region (2800–3100 cm$^{-1}$), FL-SRS microscopes containing an Er doped fiber laser and an Yb doped fiber laser (YbFL) or Yb doped fiber amplifiers were reported [4-6]. For the measurements in the fingerprint region (500–1800 cm$^{-1}$) that is a spectral region of great interest due to its excellence in material identification, FL-SRS microscopes using wavelength conversion or supercontinuum generation were reported [7, 8]. However, these approaches may sacrifice compactness and efficiency.

In order to acquire SRS images in the fingerprint region without these difficulties, we constructed a prototype of FL-SRS microscope utilizing an Nd doped fiber laser (NdFL) providing 920 nm pulses as a pump pulse source and the YbFL as a Stokes pulse source.

## 2. Experiment

Figure 1 shows a schematic of the prototype system. The wavelengths of optical pulses from the Nd/YbFL were 920/1030 nm, which correspond to a Raman shift of approximately 1160 cm$^{-1}$. The test sample was a mixture of polystyrene (PS) and PMMA beads. Spectral focusing technique [9] was used to improve the spectral resolution and tune the Raman shift.

## 3. Results

Figure 2 shows a visible light image and an SRS image of the sample. The acquisition speed was 30 frames/s, and Fig. 2(b) was the average of 30 frames. The signal-to-noise ratio (SNR) of the SRS image was 1.1. The PS beads were successfully visualized and distinguished from the PMMA beads at the Raman peak of the PS.

## 4. Conclusion

We demonstrated the feasibility of FL-SRS imaging with the NdFL in the fingerprint region. We are optimizing the NdFL and the NDFA to improve the SNR and also installing a wavelength scanner with a tunability of 300 cm$^{-1}$ [6] to perform fast spectral imaging with a wide Raman shift range.

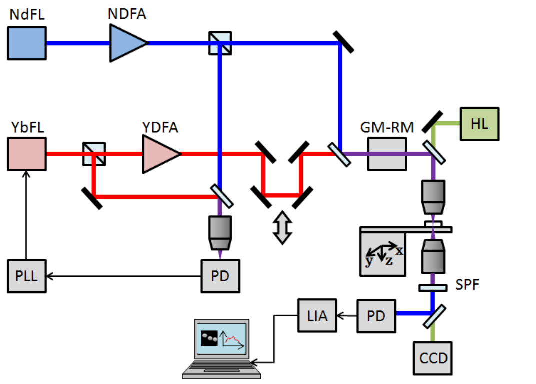
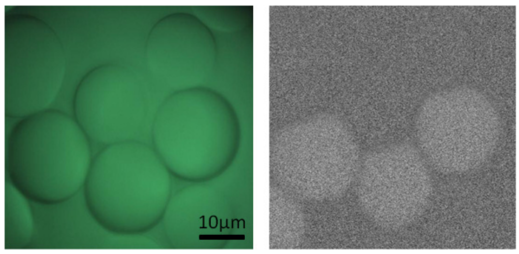



Fig. 1

A schematic of the prototype system. NDFA: Nd doped fiber optical amplifier, YDFA: Yb doped fiber optical amplifier, SPF: short-pass filter, PD: photodetector, PLL: phase locked loop, GM: Galvano mirror, RM: resonant mirror, HL: halogen lamp, LIA: lock-in amplifier. The repetition rate of the NdFL and the YbFL are 80.4 MHz and 40.2 MHz respectively. The two lasers are synchronized by the PLL based on the PD signal.




(a) (b)

Fig. 2

(a) Visible light image of measured area, (b) SRS image in the same area at the Raman signal peak.

## References

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