SUPER-RESOLUTION MICROSCOPY BY PHOTON DEPLETION

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Stimulated Raman scattering (SRS) microscopy is a chemical-specific imaging that probes the intrinsic vibrational frequencies of chemical bonds or groups. All Raman microscopies including SRS are limited in spatial resolution by the optical diffraction limit. We implement a new method for sub-diffraction SRS imaging in which the effective focal spot is reduced by a donut shaped depletion beam that eliminates SRS signal at the edge of the focal spot using a three-beam SRS scheme with a common pump beam and two Stokes beams. Here, the stimulated Raman (SR) gain of a Stokes beam is depleted by SR loss of pump photons induced by a depletion beam serving as another Stokes beam resonant to a different Raman-active mode. We obtained up to 40% depletion efficiency of the total-symmetric vibration mode of conjugated double bonds of Rhodamine 800 dye at 1640 cm^{-1} by using the CN stretching mode of the same molecule with two synchronous optical parametric oscillators (OPO) running at 80 MHz. The maximum depletion was achieved with 0.75 TW/cm^2 of 1030 nm. The expected resolution at the maximum depletion power is about 3 times enhanced compared with diffraction limit. With these experimental data, we expect a practical biological imaging based on Raman scattering with sub-150-nm resolution.