Single wavelength super-resolution imaging in fiber-optical endoscopy

Qiming Zhang and Min Gu
Centre for Micro-Photonics, Faculty of Science, Engineering and Technology, Swinburne University of Technology, Hawthorn, Victoria 3122, Australia
Email: zhang.qiming@hotmail.com

KEY WORDS: Confocal endoscopy, super-resolution, two-photon fluorescent, stimulated emission depletion.

Although fiber-optical two-photon endoscopy has been recognized as a useful diagnostic technique in vivo [1], its resolution is limited by the optical diffraction nature due to the low numerical aperture of the endoscopic optical system. On the other hand, super-resolution technique has been used to break the diffraction barrier of the resolution in a bulky microscope. Therefore, developing super-resolution technique in endoscopy is of significance for the advances of next generation of in vivo imaging. Recently, breaking diffraction-limited resolution barrier of fiber-optical two-photon endoscopy with an excitation wavelength of 800 nm has been demonstrated by introducing the stimulated emission depletion (STED) with an azimuthally-polarized beam at a wavelength of 592 nm in double-cladding fiber [2]. However, the use of two different wavelengths for the excitation and depletion increases the complexity of the optical system including multiple laser sources and filter sets. Using a single wavelength for both excitation and depletion can simplify the setup towards a compact super-resolution fiber-optical endoscopy. In this paper, we have demonstrated single wavelength super-resolution imaging in fiber-optical endoscopy with single laser source. A laser source with short pulses was used to excite the two-photon fluorescence with a high peak intensity while the same laser source was used for STED by one-photon absorption with a low peak intensity after pulse stretching. Sub-diffraction-limited imaging of the biology cells in fiber-optical endoscopy has been demonstrated by coupling the laser with short pulses and long pulses into the double-cladding fiber. Our result opens a new path of in vivo imaging endoscopy system with high resolution and compactness.

REFERENCE: