RECENT DEVELOPMENT OF FIBRE-OPTIC TWO-PHOTON FLUORESCENCE ENDOSCOPY DEVICES

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Abstract -- *We will give an overview of our recent work on fibre-optic two-photon fluorescence endoscopy devices. The main component of these devices is a single fibre coupler which acts as a low pass filter. The first device involves a lens-based probe head and the second includes a prism-based probe head.*

It has been well-known that two-photon fluorescence imaging systems offer distinct advantages over conventional single-photon arrangements including deeper penetration depth into the sample, confinement of photobleaching to the focal region and an inherent optical sectioning property. In this presentation, we will give an overview of our work on fibre-optic two-photon fluorescence microscopy and endoscopy. Two forms of two-photon fluorescence microscopy have been studied. The first system includes the delivery of ultrashort pulsed beams through a length of single-model fibres [1] and the second is based on a single-mode fibre coupler [2].

It has been found that not only the spectral width but also the spectral blue shift increases with the fibre length and illumination power due to the nonlinear response in the fibre [1]. For an illumination power of 400 mW in a 3 m long single-mode fibre, the spectral blue shift is as large as 15 nm. Such a spectral blue shift enhances the contribution from the short wavelength components within the pulsed beam and leads to an improvement in resolution under two-photon excitation, while the efficiency of two-photon excitation is slightly reduced due to the temporal broadening of the pulsed beam.

This result allows the application of an optical fibre to replace conventional bulk optics. We have found that the coupler behaves like a low-pass filter that can deliver an ultrashort pulsed laser beam of power up to 150 mW in the wavelength range from 770 nm to 870 nm as well as collect two-photon fluorescence signal in the visible range [2]. As a result of using the fibre coupler, the new two-photon imaging system exhibits a number of advantages including a compact arrangement, free of vibration from lasers and electronic devices, self-alignment, reduction of multiple scattering and an enhanced optical sectioning effect. Fig. 1 is the images of *Griffithsia* sea algae in a two-photon fluorescence microscope using a fibre coupler. The size of slices is 150 μm x 150 μm and the slice spacing is 1 μm. The excitation power is 8 mW at the focus.

Our result leads to the possibility of two-photon fluorescence endoscopy if an ultrashort pulsed fibre laser, Grin-rod lenses and prisms are used. Recently we have successfully shown that such a compact system can be used for endoscopic applications [3].

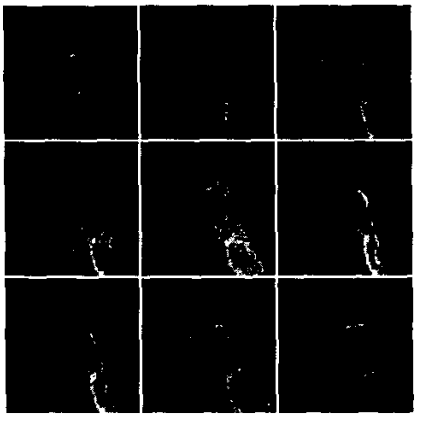

Fig. 1 Two-photon fluorescence images using a fibre coupler.

References

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