GOLD NANORODS UNDER OPTICAL MICROSCOPY

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Gold nanorods exhibit two absorption bands due to the surface plasmon resonance. The absorption peak located in the shorter wavelength region can be attributed to the oscillation along the transverse axis, which experiences relatively insignificant change with the aspect ratio (length divided by width) of nanorods. The other much stronger absorption peak resulting from the longitudinal oscillation is highly sensitive to the size variation and shifts to a longer wavelength as the aspect ratio increases. The absorption spectra for the longitudinal mode can be tuned to the near infrared region, which is highly desirable for *in vivo* applications due to less absorption, scattering and a larger penetration depth. Because of these attractive features, gold nanorods have exhibited a promising future for optical microscopy. In particular, it have been demonstrated that two-photon photoluminescence of gold nanorods can be produced when they are illuminated under an optical microscope with an ultrashort pulsed beam. Due to its large cross section, the luminescence strength of a gold nanorod is two orders of magnitude higher than a molecular dye. Thus gold nanorods render them good contrast agents for *in vivo* cancer cell imaging and treatment when they are used in conjunction with endoscopy under two-photon excitation. We will should our recent progress on nonlinear optical endoscopy toward cancer cell imaging and treatment with gold nanorods.

HeLa cells, labeled by gold nanorods have been first detected by multi-photon-excited photoluminescence endomicroscopy, which shows that multi-photon-excited photoluminescence endomicroscopy could be used in noninvasively detecting cancers. Furthermore, cells labelled with gold nanorods become highly susceptible to photothermal damage when irradiated at the plasmon resonance. Therefore multi-photon-excited photoluminescence endomicroscopy is potential for cancer cells or tumours therapy and treatment (Fig. 1). We have demonstrated the use of a radially polarised beam in the application of imaging and therapy for cancer cells labelled with gold nanorods. As a result, the energy threshold required for photothermal therapy is just one fifth of the clinical safety level. We also show that the use of a broad bandwidth supercontinuum source offers the opportunity to combine multiple nonlinear microscopic modalities, providing the complementary information on complex biological sample structures that labelled with nanorods.

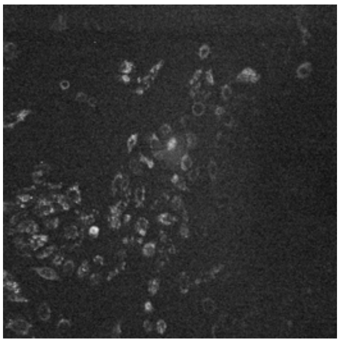

Figure 1 Two-photon-exited luminescence image of gold nanorods in a nonlinear fibre optical endoscope. Size of the image: 475 μm× 475 μm.