SUPER-RESOLUTION MULTI-PHOTON OPTICAL IMAGING WITH COLOR-TUNING RARE-EARTH DOPED NANOCRYSTALS

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Multi-photon microscopy is one of the most important optical imaging technique due to its low scattering, deep penetration depth and 3D sectioning capability via near-infrared nonlinear excitation. Usually, multi-photon microscopy requires the expensive femtosecond laser to achieve a high intensity. Rare-earth doped nanocrystals (RNCs), which have intriguing luminescent properties, such as up-conversion fluorescent and long fluorescent lifetime, are good candidates for multi-photon optical imaging. RNCs show up-conversion fluorescent via multi-photon absorption at a low excitation intensity, which can be achieved by low-cost continues-wave laser diodes. A multiple-beam optical super-resolution imaging technique with RNCs[1] has been developed to break the diffraction limit, opening a new avenue for the low power super-resolution microscopy and optical data storage[2]. However, the use of multiple 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. In this paper, we have demonstrated super-resolution optical imaging with color-tuning RNCs. The color of the up-conversion fluorescent of RNCs can be tuned between green and red by the temporal modulation of the laser at a single wavelength[3]. Super resolution imaging beyond the diffraction-limit has been achieved based on the temporal modulation of the laser at a single wavelength. Our result indicates the potential for the ultra-compact optical imaging system enabled by nanomaterials.

REFERENCE:

[1] Kolesov, R., Reuter, R., Xia, K., Stöhr, R., Zappe, A., and Wrachtrup, J., “Super-resolution upconversion microscopy of praseodymium-doped yttrium aluminum garnet nanoparticles,” Phys. Rev. B, 84, 153413 (2011).

[2] Gu, M., Zhang, Q., and Lamon, S., “Nanomaterials for optical data storage,” Nat. Rev. Mater. 1, 16070 (2016).

[3] Deng, R., Qin, F., Chen, R., Huang, W., Hong, M., Liu, X. " Temporal full-colour tuning through non-steady-state upconversion," Nat. Nanotechnol. 10, 237 (2015).