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Single photon spectral imaging with optical transition edge sensors

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Detection of single photon or small number of photons is a key technology to bring about a breakthrough to optical probes for delicate biological samples, in the bio-research and the bio-industry alike. Optical transition edge sensor (optical TES) is one of the most promising single photon detectors for such applications, with its array of features including; broadband sensitivity which ranges from visible to infrared, energy resolution, virtually zero dark count, high temporal resolution and potential extremely high detection efficiency. Here we developed a single-photon spectral imaging system, where fibre-coupled optical TES constitutes a confocal fluorescent microscope. Owing to the high quantum efficiency and virtually zero dark count of the optical TES, our imaging setup allowed using extremely faint focused laser beam to excite a fluorescent specimen, emission from which are led to the TES through an optical fibre. The energy resolution of TES allowed us to reconstruct a spectral microscopy image of the specimen without any dispersion elements (e.g. diffraction gratings). The figure shows a spectral image of a fluorescent-dye labelled mammalian cell specimen, taken with 488 nm excitation wavelength (Output under the object ~ 120 nW). The optical TES enabled to reconstruct the clear spectral image with extremely small photon count (photon count for each pixel in the figure is merely <100). These results demonstrate that the optical TES based micro spectral imaging system is capable of high-sensitivity photon spectral imaging at an extremely photon-starved regions. Taken together, our results present a blue print for a virtually non-invasive "probe without trace" optical cell analysis method, that is particularly ideal for highly demanding application such as quality control for cells used in regenerative medicines.
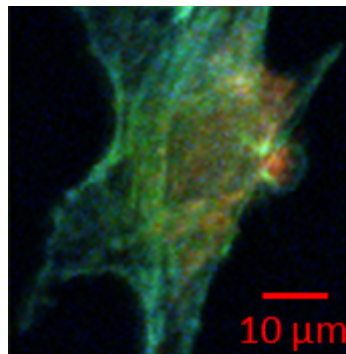
Figure 1: enter image description here

Less than 5 years of experience since completion of Ph.D

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