SUPER-RESOLUTION MICROSCOPY WITH UP-CONVERSION NANOPARTICLES

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KEY WORDS: Up-conversion nanoparticles, super-resolution, uSEE, STED, Single-nanoparticle resolution

Up-Conversion NanoParticles (UCNPs) have great promise as nanoprobes due to their photo-stability, excitation in the near-infrared spectral window, absence of autofluorescence, and emission lifetime tunability, giving novel opportunities in bio-imaging, drug delivery applications, optogenetic stimulation, and sensing solutions [1]. Interestingly, defined compositions of lanthanide-doped UCNPs have shown suitable optical properties to generate or inhibit up-converted blue emission, enabling super-resolution imaging of these nanoparticles by means of the stimulated emission depletion (STED) technique [2].

Despite the increasing interest on UCNPs, power-dependent studies of their emission at a single-nanoparticle level have been scarce in literature, and limited to specific structures/compositions. First steps of this investigation brought to the discovery of a super-linear dependence of the emission on the excitation power, enabling resolution improvement twice better than the diffraction limit, in both lateral and axial direction [3]. The up-conversion super-linear excitation-emission (uSEE) microscopy represents a straightforward super-resolution modality, not requiring complex purpose-build systems or image post-processing. An overview of uSEE current capabilities and applications in biology will be presented.

Further UCNP characterisation by varying nanoparticle composition and/or structure has been crucial for drawing a comprehensive picture of their emission properties. We used this knowledge to improve super-resolution performance specifically for biological applications. In particular, we have been focussing our work in lowering the excitation power required for UCNPs to enter sub-diffration regimes, and in pushing the super-resolution capability to distinguish single nanoparticles, even within agglomerated structures.

These results open up unique opportunities for quantitative nanoscopic investigation, such as in biology for single-site localisation within sub-cellular units or for evaluation of targeting efficiency.

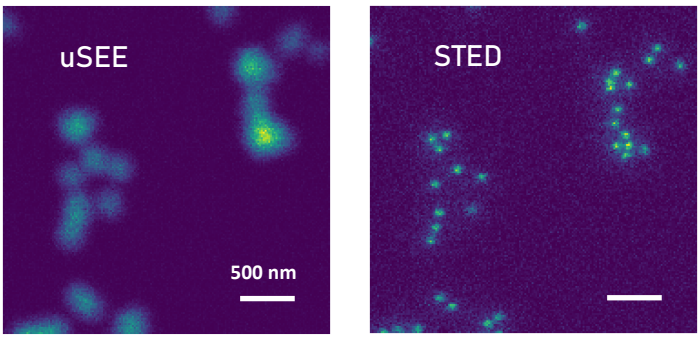

Figure : Imaging of suitable UCNPs for single-nanoparticle detection performed with uSEE and STED super-resolution techniques.

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[2] Y. Liu et al., *Nature* **543**, 229 (2017)
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