Non-covalent assemblies of upconverting nanoparticles with porphyrin-dendrimers for multiphoton imaging and sensing

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Lanthanide-based upconverting nanoparticles (UCNPs) form a class of imaging agents with unique non-linear optical properties. However, utilization of UCNPs in biomedical arena has been hampered by the lack of robust methods of their solubilization and surface functionalization. Here we show that non-covalent modification of UCNPs with polyanionic porphyrin-dendrimers converts them into stable, water-soluble, non-toxic imaging probes. UCNP-to-porphyrin excitation energy transfer enables analyte-sensitive detection by upconverted luminescence. As an example we demonstrate that UCNP/porphyrin-dendrimers make up ratiometric pH nanosensors for physiological pH range. Exceptionally high apparent multiphoton absorption cross-sections of dendritic UCNPs combined with their excellent bio-compatibility make them directly suitable for physiological imaging. Using a low power continuous wave (CW) laser for excitation we performed mapping of mouse cortical vasculature with micron-scale resolution down to 400 μm under the brain surface, setting the first precedent of true *in vivo* two-photon microscopy with CW sources.