Time-resolved imaging and sensing in the near-infrared: Towards quantitative in vivo imaging

*Yuyang Gu**

University of Technology Sydney, Ultimo NSW 2007, Australia
Institute for Biomedical Materials and Devices (IBMD)
Ultimo NSW 2007, Australia
**Yuyang.Gu@uts.edu.au*

For years, luminescence lifetime imaging has served as an indispensable tool in biological studies. Its inherent self-calibration in time domains provides quantitative insights through mechanisms such as Förster Resonance Energy Transfer (FRET). However, applying this technique in vivo introduces complexity: factors like attenuation and fluctuations in the biological environment can significantly affect the collected luminescence intensity from fluorophores. One emerging solution is to shift the emission wavelength to the near-infrared region, where reduced tissue scattering enables deeper penetration. Notably, lanthanide (III) emission centres offer tunable and stable luminescence in the 800 nm to 2000 nm range. Their typical microsecond-range lifetimes enable the exclusion of shorter-lived background signals (autofluorescence). These properties make lanthanide-based probes ideal candidates for in vivo time-resolved multiplexing and detection (Figure 1).

This report highlights my previous efforts to translate near-infrared-emitting lanthanide nanoprobes for deep-tissue, lifetime-based multiplexing and in vivo sensing. Specifically, I systematically explored strategies to optimize time-gated detection for multiplexing, improve probe efficiency[1], develop bioconjugation methods that enable interference-free quantification[2], and integrate these probes into advanced in vivo applications such as reactive oxygen species (ROS) detection[3] and temperature mapping[4]. These proof-of-concept studies lay a solid foundation for broader in vivo identification and quantification of other analytes, thus benefiting potential diagnostic and clinical translational applications.

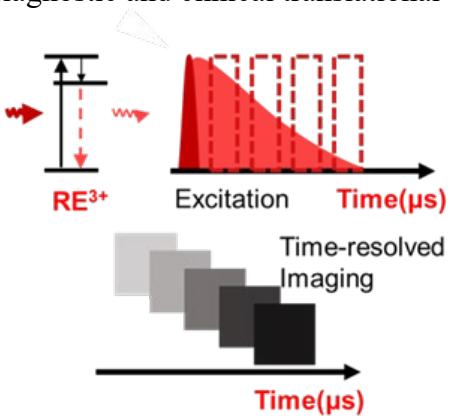

Figure 1: Schematic illustration of time-resolved luminescence detection and imaging of lanthanide-based nanoprobes

References:

1. Gu Y, Guo Z, Yuan W, et al. *Nature Photonics*, **2019**, 13(8): 525-531
2. Liu Y, Gu Y, Yuan W, et al.. *Advanced Science*, **2020**, 7(11): 1902929
3. Kong M, Gu Y, Liu Y, et al. *Small*, **2019**, 15(46): 1904487
4. Kong M, Gu Y, Chai Y, et al. *Science China Chemistry*, **2021**, 64(6): 974-984