Time-Gated Near-Infrared Detection of Avian Influenza Virus with High-Contrast Luminescence from Long-Lived Nanoparticles

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Near-infrared (NIR)-to-NIR upconversion nanoparticles (UCNPs) are attractive candidates for biomedical imaging and sensing. However, achieving both long luminescence lifetimes and strong emission intensity remains a major challenge, often limiting the performance of time-gated imaging in terms of resolution and sensitivity. To address this, we engineered NIR long-lifetime luminescent nanoparticles (NLL NPs) that emit strongly at 800 nm by integrating a photosensitizing shell and optimizing the activator concentration to extend lifetime. NLL NP-based time-gated imaging overcomes the intrinsic limitations of steady-state imaging, offering significantly higher signal-to-noise ratios and more reliable signal output for enhanced detection performance. When applied to a lateral flow immunoassay (LFA) for avian influenza virus detection, NLL NPs-based time-gated imaging achieved a 32-fold lower detection limit than conventional 800 nm emitting probes. Clinical evaluation with 65 patient samples confirmed excellent diagnostic performance, yielding 100% sensitivity and specificity with an AUC of 1.000. This work highlights the strong potential of NLL NPs-based time-gated imaging for high-accuracy, high-sensitivity diagnostics in complex clinical settings.

References

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[2] Kim, S., Ryoo, S., Park, E.-K. *et al*. Acs Sensors 8, (2023) 1299-1307

Figures

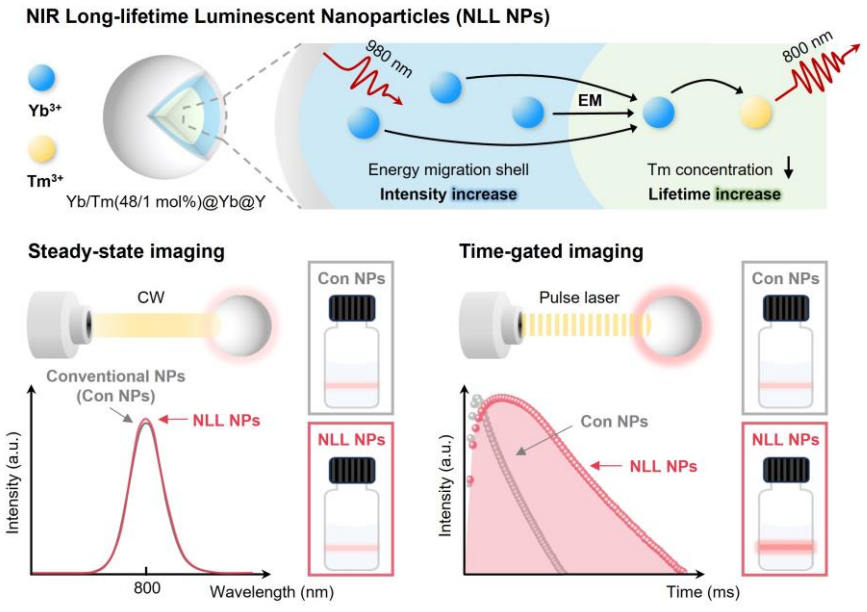

Figure 1: Schematic illustration of NIR long-lifetime luminescent nanoparticles (NLL NPs) with long lifetimes and bright emissions, which are advantageous for background-free detection using a time-gated imaging strategy.