**Supplementary information**

Yuxin Liu *et al.* Multi-channel NIR/SWIR Lanthanide Nanoprobe for Forensic Gender Identification of Fingerprints



**Supplementary figure 1.** TEM images of NaLuF4:Yb,Tm a), NaLuF4:Yb,Tm@NaLuF4 b) and NaLuF4:Yb,Tm@NaLuF4@mSiO2 c). HR-TEM image of NaLuF4:Yb,Tm@NaLuF4@mSiO2 is inserted. d) Diameter distribution of NaLuF4:Yb,Tm, NaLuF4:Yb,Tm@NaLuF4, NaLuF4:Yb,Tm@NaLuF4@mSiO2 and Tm-rSiMo.



**Supplementary figure 2.** XRD pattern a) and 95Mo NMR spectrum b) of Tm-SiMo. The standard pattern on bottom is assigned to hexagonal phase NaLuF4 (JCPDS: 027-0726). The sphere-marked peaks in XRD pattern is contributed to SiMo (JCPDS: 79-2426). The δ at 17.2 ppm in 95Mo NMR spectrum is contributed to Mo atom in α-keggin SiMo. UV-vis-NIR c) and EPR d) spectra of Tm-SiMo and Tm-rSiMo. The g-factor at ~1.92 in EPR spectrum is contributed to MoV in Tm-rSiMo.



**Supplementary figure 3.** a) DLS of Tm-rSiMo with and without L-AAO modification. b) Detached L-AAO in supernatant of Tm-rSiMo-AAO dispersion after various storage periods. *Abs.*595 of ninhydrin is used as an indicator and free L-AAO solution is used as a positive control group. c) Oxidation level of Tm-rSiMo-AAO dispersion after various storage periods. *Abs.*800 of rSiMo is used as an indicator and H2O2-added Tm-rSiMo-AAO dispersion is used as a positive control group. d) Enzymatic activity of Tm-rSiMo-AAO dispersion after various storage periods. All samples are pre-treated with mimic L-AA working solution. *Abs.*800 of rSiMo is used as an indicator and Tm-rSiMo dispersion is used as a positive control group. Freshly prepared Tm-rSiMo-AAO dispersion is used as a negative control group. Data are represented as mean ± SD.



**Supplementary figure 4.** a) Enzymatic activity of L-AAO in various pH conditions. CV curves b) and Mo2p XPS spectra c) of Tm-rSiMo-AAO in absence and presence of L-AA. The two sphere-marked peaks in CV curves are corresponded to SiMo. d) Absorbance (up) and luminescence (bottom) of Tm-rSiMo in same NIR and SWIR spectral range. Data are represented as mean ± SD.



**Supplementary figure 5.** NIR/SWIR of Tm-rSiMo-AAO in addition with various typical ions a) and biomolecules b) in fingerprints. The biomolecule mainly refer to albumin, fatty acids and other small molecules, including human serum albumin (HSA), octanoic acid (OOA), decanoic acid (DOA), palmitic acid (PTA), octadecanoic acid (ODOA), arachidic acid (ADA) 2-hydroxypropanoic acid (2-HA) and glucose (Glc). Data are represented as mean ± SD.



**Supplementary figure 6.** NIR a) and SWIR b) images of fingerprints of female and male.

**Supplementary table 1.** Average L-AA concentration (mM) values for males and females derived from fingerprints.

|  |  |  |  |
| --- | --- | --- | --- |
| **L-AA** | **Female** | **Male** | **Female/Male ratio** |
| Thr | 0.2090 | 0.1121 | 1.8644 |
| Ser | 0.9840 | 0.5208 | 1.8894 |
| Glu | 0.1780 | 0.1109 | 1.6050 |
| Gly | 0.6463 | 0.3418 | 1.8909 |
| Ala | 0.3870 | 0.1968 | 1.9665 |
| Cit | 0.1967 | 0.1267 | 1.5525 |
| Asp | 0.1196 | 0.0638 | 1.8746 |
| Asn | 0.0380 | 0.0161 | 2.3602 |
| Gln | 0.0178 | 0.0120 | 1.4833 |
| Pro | 0.0728 | 0.0349 | 2.0860 |
| Val | 0.0919 | 0.0459 | 2.0022 |
| Cys | 0.0012 | 0.0009 | 1.3333 |
| Met | 0.0085 | 0.0034 | 2.5000 |
| Iso | 0.0494 | 0.0229 | 2.1572 |
| Leu | 0.0625 | 0.0324 | 1.9290 |
| Tyr | 0.0559 | 0.0303 | 1.8449 |
| Phe | 0.0378 | 0.0172 | 2.1977 |
| *β*-ala | 0.0128 | 0.0034 | 3.7647 |
| Orn | 0.1361 | 0.0684 | 1.9898 |
| Lys | 0.0528 | 0.0285 | 1.8526 |
| Trp | 0.0151 | 0.0071 | 2.1268 |
| His | 0.1790 | 0.0804 | 2.2264 |
| Arg | 0.0948 | 0.0540 | 1.7556 |
| **Total** | **3.6470** | **1.9307** | **1.8889** |