## **Electronic Supplementary Information**

Gold nanoparticle core - europium (III) chelate fluorophore-doped silica shell hybrid nanocomposite for lateral flow immunoassay of human thyroid stimulating hormone with dual signal readout

Pattarachaya Preechakasedkit<sup>a,1</sup>, Kota Osada<sup>b,1</sup>, Nipapan Ruecha<sup>b</sup>, Yuta Katayama<sup>b</sup>, Koji Suzuki<sup>b</sup>, Orawon Chailapakul<sup>c\*</sup>, Daniel Citterio<sup>b\*</sup>

<sup>a</sup> Program in Biotechnology, Faculty of Science, Chulalongkorn University, Patumwan, Bangkok, 10330, Thailand.

<sup>b</sup> Department of Applied Chemistry, Faculty of Science and Technology, Keio University, Yokohama, Kanagawa, 223-8522, Japan

<sup>c</sup> Electrochemistry and Optical Spectroscopy Center of Excellence (EOSCE), Department of Chemistry, Faculty of Science, Chulalongkorn University, Patumwan, Bangkok, 10330, Thailand

\*Corresponding authors e-mail: citterio@applc.keio.ac.jp, corawon@chula.ac.th

<sup>1</sup> These authors contributed equally to this work

## **Table of contents**

Figure S1	Drawing positions of test and control lines on nitrocellulose	S2
Figure S2	TEM image of gold core nanoparticles	S2
Figure S3	TEM images of AuNPs@SiO <sub>2</sub> -Eu <sup>3+</sup> nanocomposite particles	S3
Figure S4	Fabrication reproducibility for ballpoint pen line drawing method	S4
Figure S5	LFIA devices based on conventional AuNP antibody labels	S4



Figure S1 Nitrocellulose membrane with drawing position of T and C lines indicated.



Figure S2 TEM image of AuNPs used as core.



**Figure S3** TEM images of AuNPs@SiO<sub>2</sub>-Eu<sup>3+</sup> nanocomposites after different numbers of APTES-BTBCT-Eu<sup>3+</sup> fluorophore doping cycles from (a-d) 1, 3, 5 and 7 layers.



**Figure S4** (a) Photograph of a ballpoint pen mounted in a craft cutting device, and (b) Gray scale intensity of the control line of 7 independently ballpoint pen fabricated LFIA devices.



Figure S5 (a) Photograph of AuNPs-based LFIAs applied to the detection of various concentrations of hTSH from 0-100  $\mu$ IU/mL; and (b) corresponding calibration curve obtained by gray scale analysis of test lines, error bars indicate the standard deviations for measurements performed in triplicate.