

## Electronic Supplementary Material

### Surface-enhanced Raman scattering ultrasensitive detection of $\text{Pb}^{2+}$ using L-cysteine-functionalized bismuth nanoparticles and electrodeposited bismuth film substrates

Tao Zhou<sup>2</sup>, Liying Song<sup>2</sup>, Hongmeng Ding<sup>2</sup>, Jing Wang<sup>2</sup>, Lina Sui<sup>2</sup>,  
Na Song (✉)<sup>1,3</sup>, Liyan Yu (✉)<sup>2,4</sup>, Qingli Wei (✉)<sup>4</sup>, and Lifeng Dong (✉)<sup>2,5</sup>

1 College of Biological Engineering, Qingdao University of Science and Technology, Qingdao 266042, China

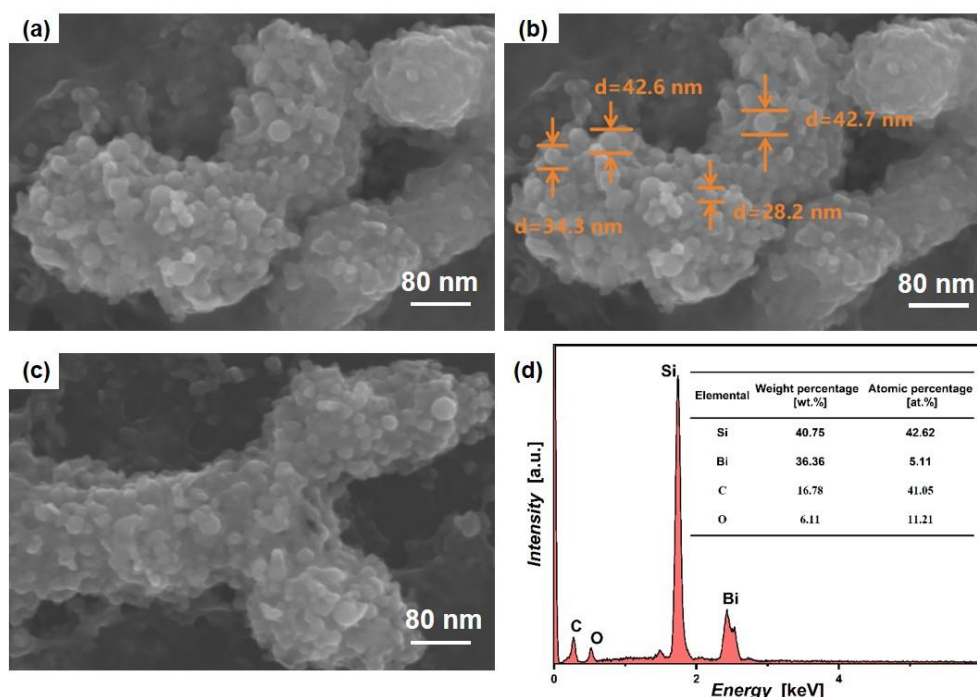
2 College of Materials Science and Engineering, Qingdao University of Science and Technology, Qingdao 266042, China

3 Shandong Sinocera Functional Material Co., Ltd., Dongying 257000, China

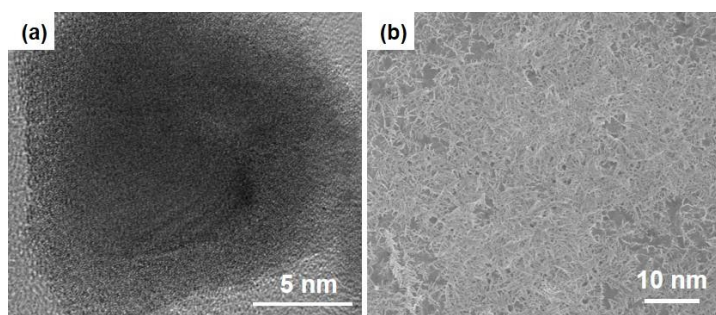
4 Qingdao University of Science & Technology Analytical & Testing Center, Qingdao 266042, China

5 Department of Physics, Hamline University, St. Paul, MN 55104, USA

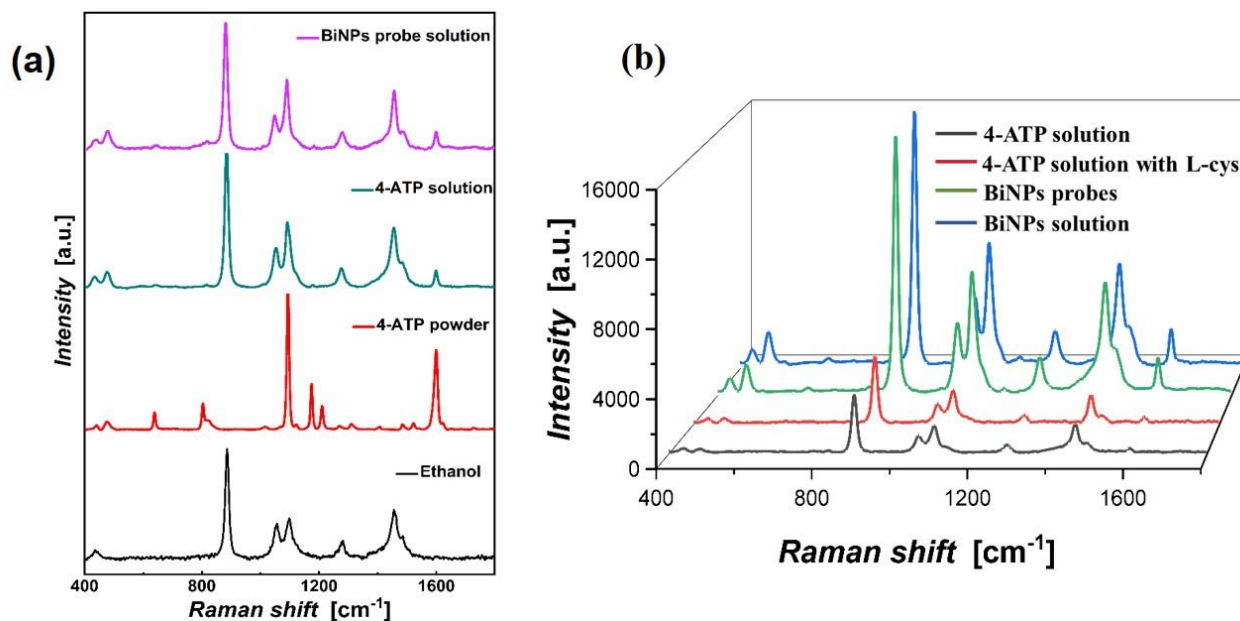
E-mails: songna@qust.edu.cn (N.S.), donglifeng@qust.edu.cn (L.D.), liyanu@qust.edu.cn (L.Y.), lily\_qd72@126.com (Q.W.)



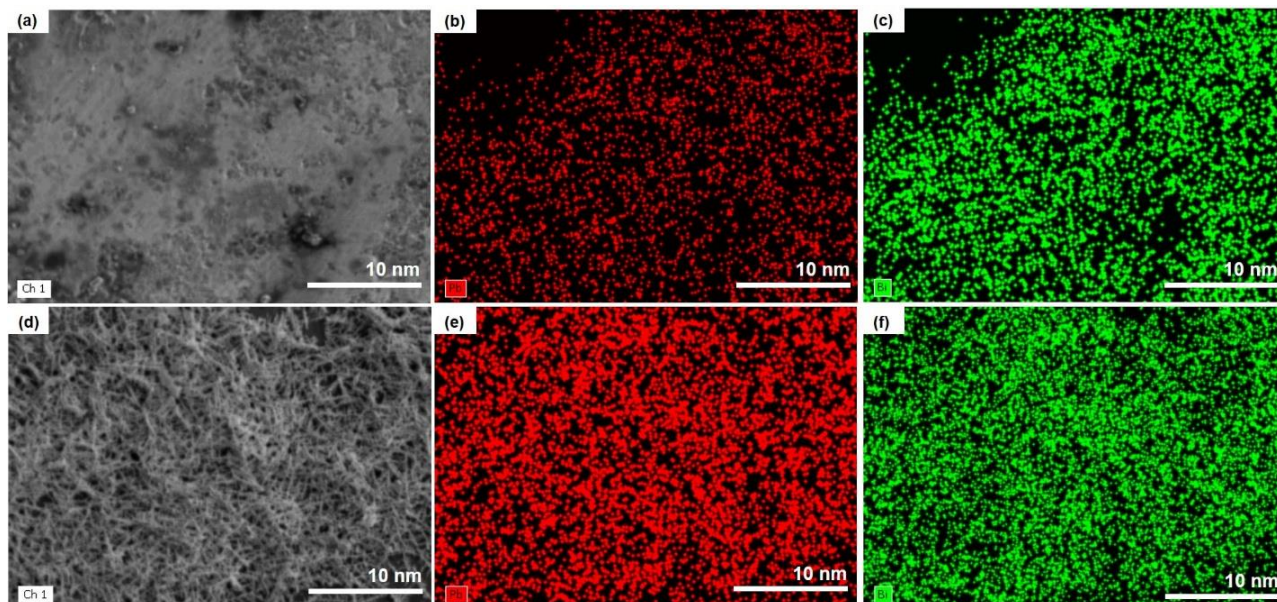
**Fig. S1** (a)(b)(c) SEM images and (d) EDS spectrum of BiNPs.



**Fig. S2** (a) TEM image of BiNPs and (b) SEM image of electrodeposited bismuth film.



**Fig. S3** (a) SERS spectra of ethanol, 4-ATP powder, 4-ATP solution, and BiNPs probe solution. (b) SERS spectra of 4-ATP solution, 4-ATP solution with L-Cys, BiNPs solution, and BiNPs probe.



**Fig. S4** Mapping images of BiNPs probes: (a)(b)(c) with Pb<sup>2+</sup> dried in pure bismuth flake; (d)(e)(f) with Pb<sup>2+</sup> dried in electrodeposited bismuth film.