Supporting Information for

Optoelectrofluidic Sandwich Immunoassays for Detection of Human Tumor Marker Using Surface-Enhanced Raman Scattering

Hyundoo Hwang,† Hyangah Chon,‡ Jaebum Choo,*‡ and Je-Kyun Park*,†,§

† Department of Bio and Brain Engineering, Korea Advanced Institute of Science and Technology (KAIST), 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea

‡ Department of Bionano Engineering, Hanyang University, 1271 Sa-1-dong, Sangnok-gu, Ansan, Kyeonggi-do 426-791, Republic of Korea

§ KAIST Institute for the NanoCentury, 335 Gwahangno, Yuseong-gu, Daejeon 305-701, Republic of Korea

* To whom correspondence should be addressed. Fax: +82-42-350-4310. E-mail: (J.-K.P.) jekyun@kaist.ac.kr; (J.C.) jbchoo@hanyang.ac.kr.
S1. Simulation Study

The simulated results of the electric field distribution and the ACEO flows in the optoelectrofluidic device are shown in Figure S1. The ACEO fluid velocity was simulated as a slip condition at the surface of the photoconductive layer. For the simulation, the Debye length was calculated using Gouy–Chapman equation as 55.7 nm. The voltage drop across each layer was calculated using an equivalent circuit model.\(^1\) When the ac voltage of 10 V\(_{pp}\) at 1 kHz was applied the voltage drop across the sample solution was calculated as 7.2 V\(_{pp}\) in the illuminated area. According to the simulation, the ACEO flows would occur toward the illuminated area along the surface of the photoconductive layer. By the viscous property of the fluids, the vortices would be induced in the sample solution around the edges of the image pattern. The direction and the relative magnitude of the negative DEP force acting on the microspheres were easily predictable based on the distribution of the electric field. The electric field was the strongest at the edge of the projected LCD image. Therefore, the negative DEP force repels microspheres from the image pattern to the dark area. The optically induced electrokinetic forces acting on the particles, which include the ACEO drag and the DEP forces, would be much stronger around the edge of the LCD image than other regions. Through this simulation study, we could estimated that the microspheres, which are supporting substrates for immunocomplexes, would be concentrated into the dark area by the combination of negative DEP, ACEO, and gravity when the LCD image pattern moves continuously. On the other hand, the probe nanoparticles and the antigens, which were not bound onto the microspheres, would be washed out by strong ACEO flows diverging from the dark area, where the immunocomplexes were concentrated.

REFERENCE

Figure S1. Simulation results for the electric field distribution and the optically induced ACEO flows (blue arrows) in an optoelectrofluidic device. According to the LCD image pattern (red), the electric field distribution and the ACEO flow pattern are also changed.
S2. SERS Spectra for Raman Probes, Immunocomplexes and Antigens

SERS spectra for Raman reported-labeled AgNPs, for final sandwich immunocomplexes, and for complexes of AFP antigens and antibody-conjugated AgNPs have been measured and compared. As shown in Figure S2, the SERS intensities of AFP and antibodies were negligible compared to those of Raman probe, MGITC. Therefore, the amount of AFP antigens in the immunocomplexes could be quantified by measuring the SERS signal of MGITC.

![Figure S2. SERS spectra for (a) MGITC-labeled AgNPs, (b) for final sandwich immunocomplexes, and (c) for complexes of AFP and AFP antibody-conjugated AgNPs.](image-url)