Supporting Information

Surfactant-Free Vapor-Phase Synthesis of Single-crystalline Gold Nanoplates for Optimally Bioactive Surfaces

Youngdong Yoo,†&‡ Hyoban Lee,†‡ Hyunsoo Lee,‖§ Miyeon Lee,‡ Siyeong Yang,‡
Ahreum Hwang,†# Si-in Kim,‡ Jeong Young Park,‖§ Jaebum Choo,⁺ Taejoon Kang,⁎§∥⁺
and Bongsoo Kim⁎†

†Department of Chemistry, KAIST, Daejeon 34141, Korea
‡Department of Chemistry, University of Minnesota, Minneapolis MN 55455, USA
‖Center for Nanomaterials and Chemical Reactions, IBS, Daejeon 34141, Korea
§Graduate School of EEWS, KAIST, Daejeon 34141, Korea
#Hazards Monitoring Bionano Research Center, KIRBB, Daejeon 34141, Korea
⁺Department of Bionano Engineering, Hanyang University, Ansan 15588, Korea
⁰BioNano Health Guard Research Center, KIRBB, Daejeon 34141, Korea
⁺Department of Nanobiotechnology, KIRBB School of Biotechnology, UST, Daejeon 34113, Korea

⁎To whom correspondence should be addressed.
E-mail: bongsoo@kaist.ac.kr (B.K.)
E-mail: kangtaejoon@kirbb.re.kr (T.K.)

†These authors contributed equally to this work.
1. Thin and small Au nanoplates grown on r-cut sapphire substrate

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**Figure S1.** (a) Top-view, (b) 20˚ tilted-view, and (c) 40˚ tilted-view SEM images of small Au nanoplates grown on r-cut sapphire substrates.
2. Magnified AFM topographic image of Au nanoplate

**Figure S2.** (a) Magnified AFM topographic image of Au nanoplate in Figure 2a. The scale is 3 µm × 3 µm. (b) Sectional view along a dotted cyan line in (a). The surface-height variation is between -0.2 nm and 0.2 nm with 0.10 nm of $R_q$. (c) Surface height distribution of (b).
3. Epitaxial relationship at the interface between Au seed NP and $m$-cut sapphire substrate

**Figure S3.** Schematic illustration of atomic planes at the epitaxial interface between Au (113) and sapphire (10\[\bar{1}\]0) planes. 9 layers of Au and 2 layers of sapphire have 0.1% domain-matched misfit along Au $<1\bar{1}0>$//sapphire $<0\bar{0}01>$ direction. The lattice spacing of the Au (110) plane is 1.44 Å and that of the sapphire (0001) plane is 6.49 Å.
4. Selective synthesis of Au nanostructures by deposition flux

Figure S4. 45° tilted-view SEM images of (a) Au NWs, (b) nanobelts, and (c) nanoplates grown at a precursor temperature of 1100 °C, 1150 °C, 1200 °C, respectively. The temperature of m-cut sapphire substrates were maintained at 1000 °C for all experiments.
5. Synthesis of horizontal Au NWs in very high deposition flux condition

Figure S5. (a) Top-view and (b) Magnified and 45° tilted-view SEM images of horizontal Au NWs on m-cut sapphire substrate. Au power was used as a precursor instead of Au lump to increase the deposition flux of Au atoms. The precursor temperature was 1200 °C.
6. Au NPs on a nanoplate structure through the biotin-avidin interaction

Figure S6. Schematic illustration of the construction process of Au NPs on a nanoplate structure through the biotin-avidin interaction.
7. Full SERS spectra corresponding Figure 6f

**Figure S7.** SERS spectra obtained from (a) Au NPs on a nanoplate structures and (b) Au NPs on a film structures with various avidin concentrations (0 M, 10 pM, 100 pM, and 1 nM). The ultraflat Au nanoplate-based SERS sensor has a detection limit of 10 pM, whereas the rough Au film-based SERS sensor has a detection limit of 1 nM.
8. SEM images of Au NPs on Au nanoplate and Au film

Figure S8. SEM images of Au NPs attached on (a-d) Au nanoplate and (e-h) Au film at various concentrations of avidin (0 M, 10 pM, 100 pM, 1 nM).