Electronic Supplementary Information

Water-dispersible ultrathin Au nanowires prepared using a lamellar template of a long-chain amidoamine derivative

Yoshiro Imura, Hiromitsu Tanuma, Hiroki Sugimoto, Reizo Ito, Satoshi Hojo, Hiroshi Endo, Clara Morita and Takeshi Kawai*

Department of Industrial Chemistry, Tokyo University of Science
1-3, Kagurazaka, Shinjuku-ku, Tokyo, 162-8601, Japan
kawai@ci.kagu.tus.ac.jp

Synthesis of C18ME:[1]

10.22 g (0.12 mol) of methyl acrylate was added to 2.0 g (7.12 mmol) of octadecylamine in 15 mL of methanol. The solution was stirred at 40 °C for 3 days and the solvents and excess methyl acrylate were then removed by rotary evaporation. 3-[(2-methoxycarbonyl-ethyl)-octadecyl-amino]-propionic acid methyl ester (C18ME) was obtained as a viscous liquid.

^{1}H NMR ($CDCl_3$): δ 0.88 (t, 3H, $CH_2\mathbf{CH_3}$), 1.25 (br, 28H, CH_2), 1.42 (br, 4H, $\mathbf{CH_2}CH_3$, $CH_2\mathbf{CH_2}CH_2N$), 2.37 (t, 4H, $CH_2\mathbf{CH_2}CO$), 2.43 (t, 2H, CH_2N), 2.76(t, 4H, $N\mathbf{CH_2}CH_2CO$), and 3.66 (s, 6H, $O\mathbf{CH_3}$) ppm. HRMS: calcd for C18ME ($M+Na^+$) 464.37, found 464.38.

Synthesis of C18AA:[1]

C18ME (3.2 g) and ethylenediamine 17.8 g (0.30 mol) were dissolved in 15 mL of methanol and the mixture was stirred for 1 week at room temperature. Upon removal of the solvent and ethylenediamine by evaporation and freeze-drying, C18AA was obtained as a light yellow solid. The crude solid was recrystallized from a mixed solvent of toluene and methanol. Yield: 90%.

^{1}H NMR ($CDCl_3$): δ 0.88 (t, 3H, CH_3), 1.25 (br, 28H, CH_2), 1.45 (br, 4H, **CH_2**CH_3, CH_2**CH_2**CH_2N), 2.36 (t, 4H, CH_2**CH_2**O), 2.42 (t, 2H, **CH_2**N), 2.73 (t, 4H, N**CH_2**CH_2CO), 2.82 (t, 4H, **CH_2**NH_2), and 3.29 (q, 4H, NH**CH_2**) ppm. HRMS: calcd for C18AA ($M+H^+$) 498.47, found 497.48.

Synthesis of C18ASH

C18ME (3.2 g) and 2-aminoethanthiol 11.4 g (0.15 mol) were dissolved in 20 mL of methanol and the mixture was stirred for 2 weeks at room temperature. Upon removal of the solvent and 2-aminoethanthiol by evaporation and freeze-drying, C18ASH was obtained as a light yellow solid. The crude solid was recrystallized from acetone.

^{1}H NMR ($CDCl_3$): δ 0.88 (t, 3H, CH_3), 1.25 (br, 28H, CH_2), 1.45 (br, 4H, **CH_2**CH_3, CH_2**CH_2**CH_2N), 2.37 (t, 4H, CH_2**CH_2**O), 2.60 (t, 2H, **CH_2**N), 2.81 (t, 4H, N**CH_2**CH_2CO), 2.87 (t, 4H, **CH_2**SH), and 3.55 (q, 4H, NH**CH_2**) ppm.

NMR spectra were recorded in $CDCl_3$ using a Bruker 400 Ultrashield spectrometer operating at 400 MHz.

[1] Y. Imura, C. Morita, H. Endo, T. Kondo, T. Kawai, *Chem. Chemmun.*, **2010**, *46*, 9206-9208.; C. Morita, H. Sugimoto, K. Matsue, T. Kondo, Y. Imura, T. Kawai, *Chem. Chemmun.*, **2010**, *46*, 7969-7971.

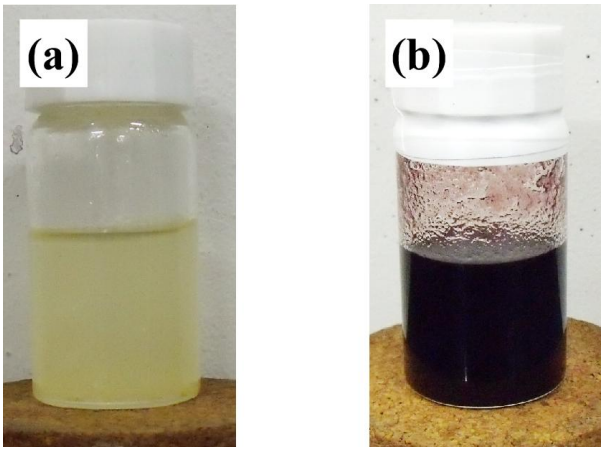

Figure S1. Photographic images of (a) before adding $LiEt_3BH$ as reducing agent and (b) after adding $LiEt_3BH$ and left without stirring for 8h at 55 °C.

TEM-EDX Measurement : TEM-EDX spectra of ultrathin Au NWs indicated that ultrathin Au NWs were composed of pure gold. The Cu and Fe peaks were from TEM copper grid.[2]

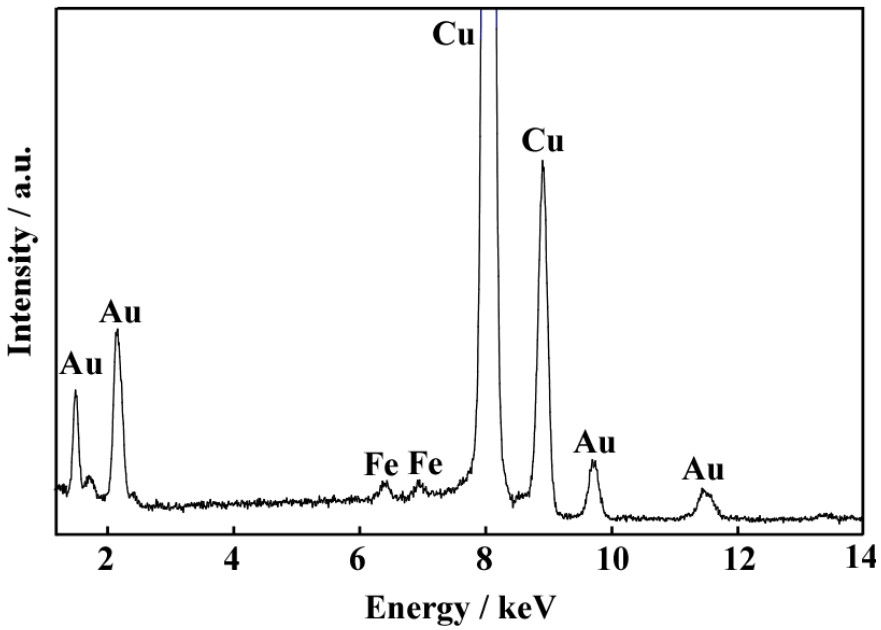

Figure S2. TEM-EDX spectra of ultrathin Au NWs.

[2] H. Feng, Y. Yang, Y. You, G. Li, J. Guo, T. Yu, Z. Shen, T. Wu, B. Xing. *Chem. Chemmun.* 2009, **15**, 1984.

XRD Measurement : The C18AA toluene gel (1 g) containing the as-prepared ultrathin Au NWs were added into ethanol (5 g) and centrifuged at 4500 rpm for 15 min in order to remove Au NPs and excess C18AA. The precipitation was used for XRD measurement. The peak positions appeared at 38.2°, 44.3°, 64.5° and 77.6°, the structure of ultrathin Au NWs prepared from C18AA is similar that of previously reported Au NWs prepared from the oleylamine system.[3]

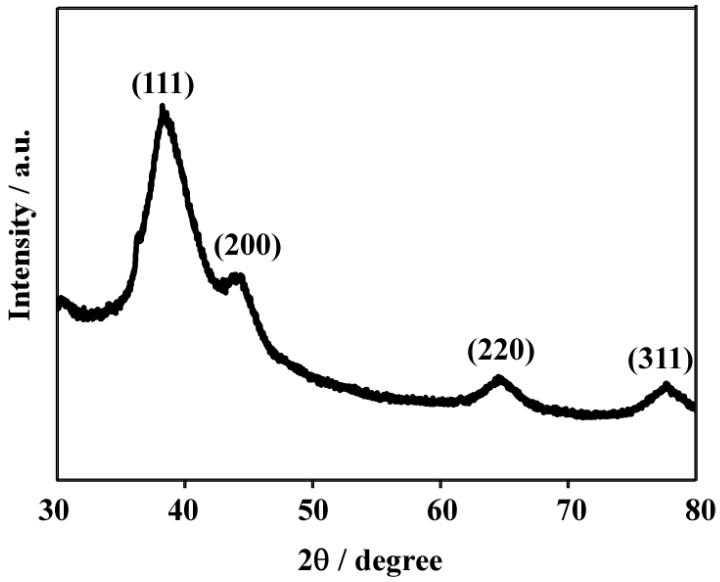

Figure S3. XRD pattern of ultrathin Au NWs.

[3] H. Feng, Y. Yang, Y. You, G. Li, J. Guo, T. Yu, Z. Shen, T. Wu, B. Xing. *Chem. Chemmun.* 2009, **15**, 1984.; C. Wang, Y. Hu, C. M.Lieber, S. Sun, *J. Am. Chem. Sco.*, 2008, **130**, 8902.

TEM images

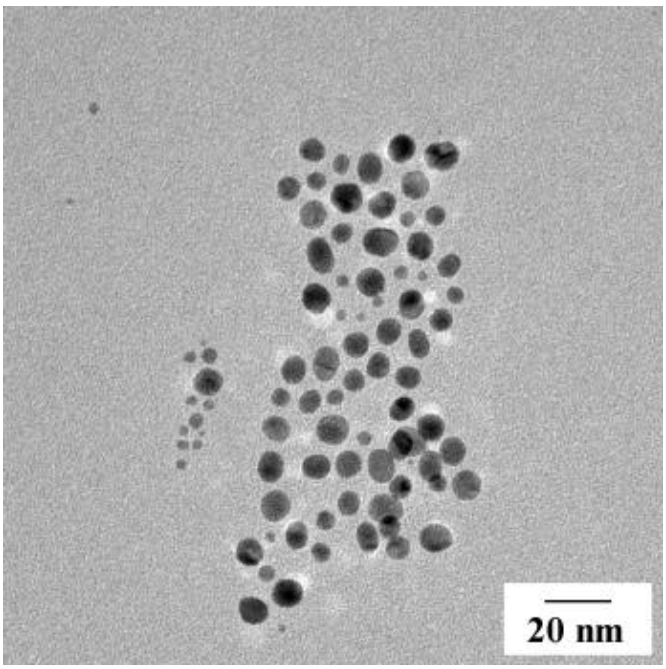

Figure S4. TEM image of Au NPs synthesized in ethanol as a non-gelation solvent.

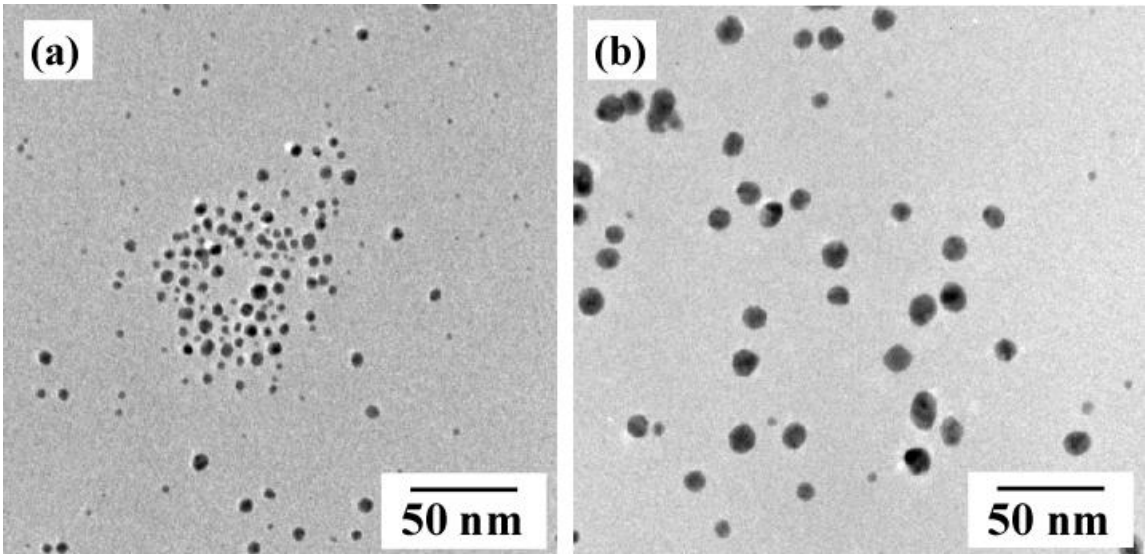

Figure S5. TEM images of Au NPs synthesized in (a) 0.5 wt% C18AA in toluene at 55 °C for 8 h, and in (b) 2 wt% C18AA in toluene at 85 °C for 8 h.

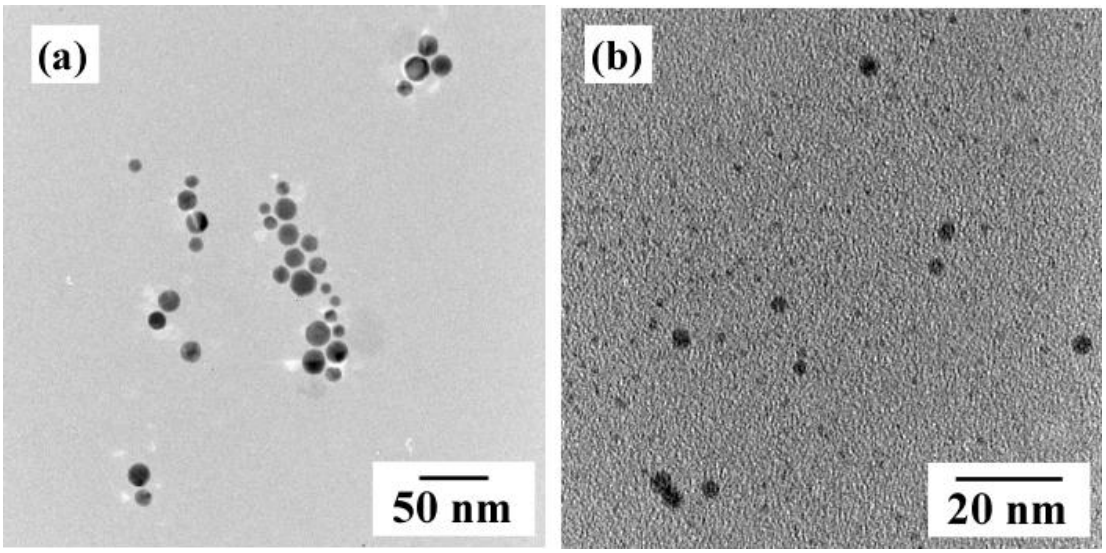

Figure S6. TEM images of Au NPs synthesized in (a) 2 wt% C18AOH in toluene and (b) 2 wt% C18ASH in toluene at 55 °C for 8 h.

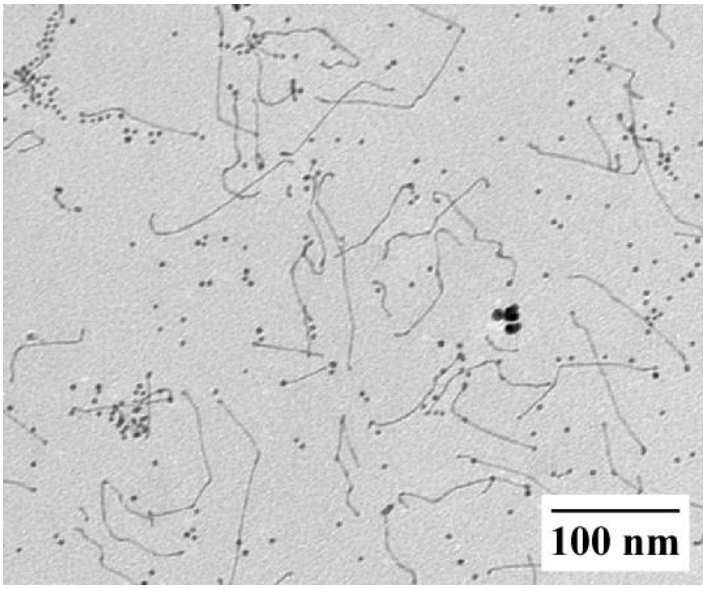

Figure S7. TEM image of ultrathin Au NWs capped with 1- dodecanethiol after ligand change.

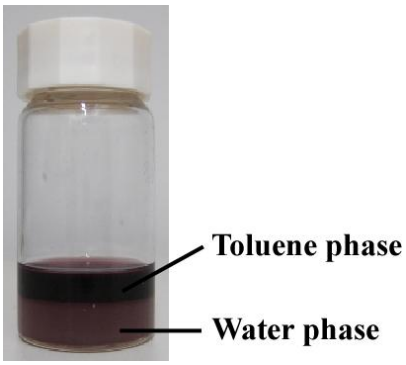

Figure S8. Photographic image after adding water to C18AA toluene gel containing the as-prepared Au NWs.