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The Mechanism of Alkylamine-Stabilized Copper Fine Particles towards Improving Electrical Conductivity of Copper Films at Low Sintering Temperature

Yingqiong Yong,[a] Tetsu Yonezawa,*[a] Masaki Matsubara,[a] and Hiroki Tsukamoto[a]

[a]*Division of Materials Science and Engineering, Faculty of Engineering,*

Kita 13 Nishi 8, Kita-ku, Sapporo, Hokkaido 060-8628, Japan

Supporting Information

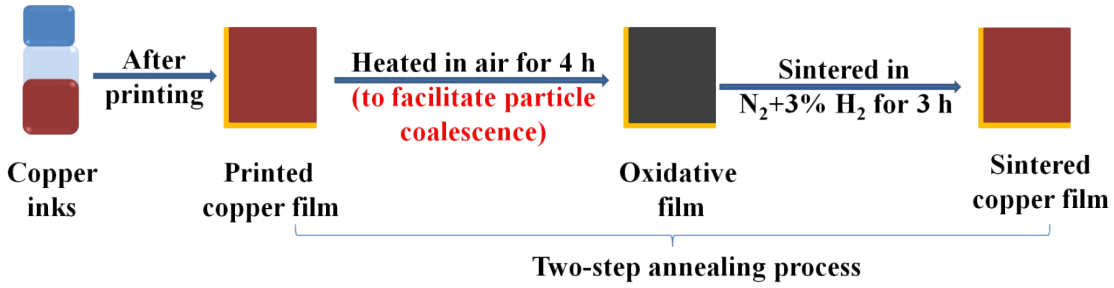

Figure S1 Schematic diagram of two-step annealing process including oxidative preheating process in air for 4 h (to facilitate particle coalescence by generating convex surfaces, nanorods or nanoparticles) and reductive sintering in 3% hydrogen-containing nitrogen gas for 3 h. The temperature during this two-step annealing process was 200 °C, 250 °C or 300 °C.

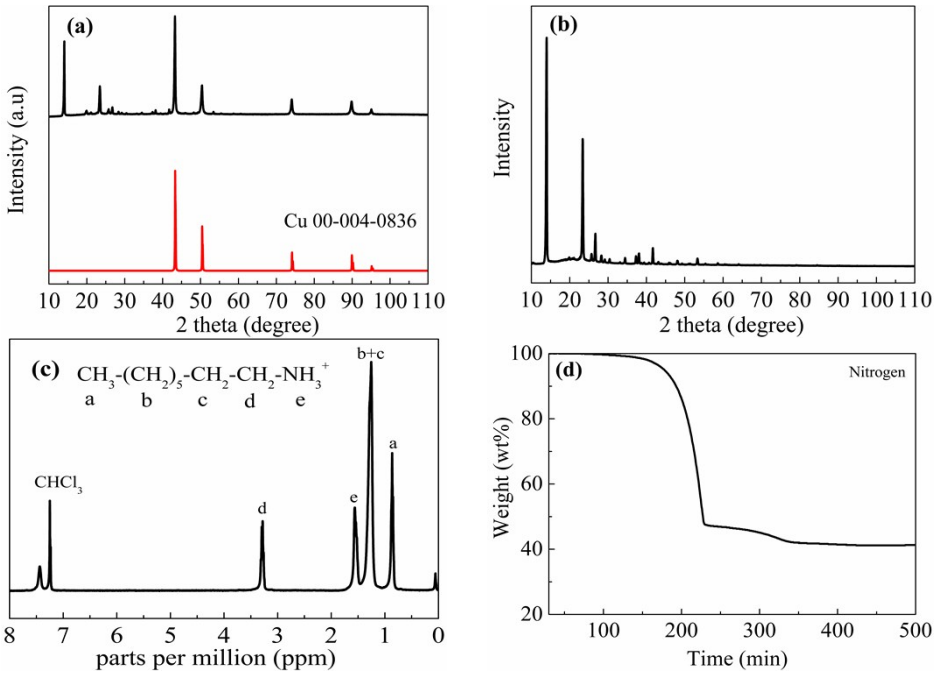

Figure S2 XRD patterns of (a) copper particles with much protonated octylamine (copper **B** fine particles) and (b) Protonated octylamine. (c) NMR spectra of protonated octylamine. (d) TG curves of copper **B** particles in nitrogen.

After centrifugation using methanol for 3 times, small amounts of protonated octylamine were collected by evaporation of the supernatant. It was analyzed by XRD and ^{1}H NMR (JEOL ECS 400) measurements (Figures S2b-c). The peaks of obtained protonated octylamine in XRD agree with the undefined peaks in Figure S2a. The NMR result shows these peaks in Figure S2b can be mainly attributed to the protonated octylamine with remaining impurities peak at 7.4 ppm. The TG result shown in Figure S2d exhibits copper **B** particles are composed of 41 wt% of copper and 59 wt% of organics.

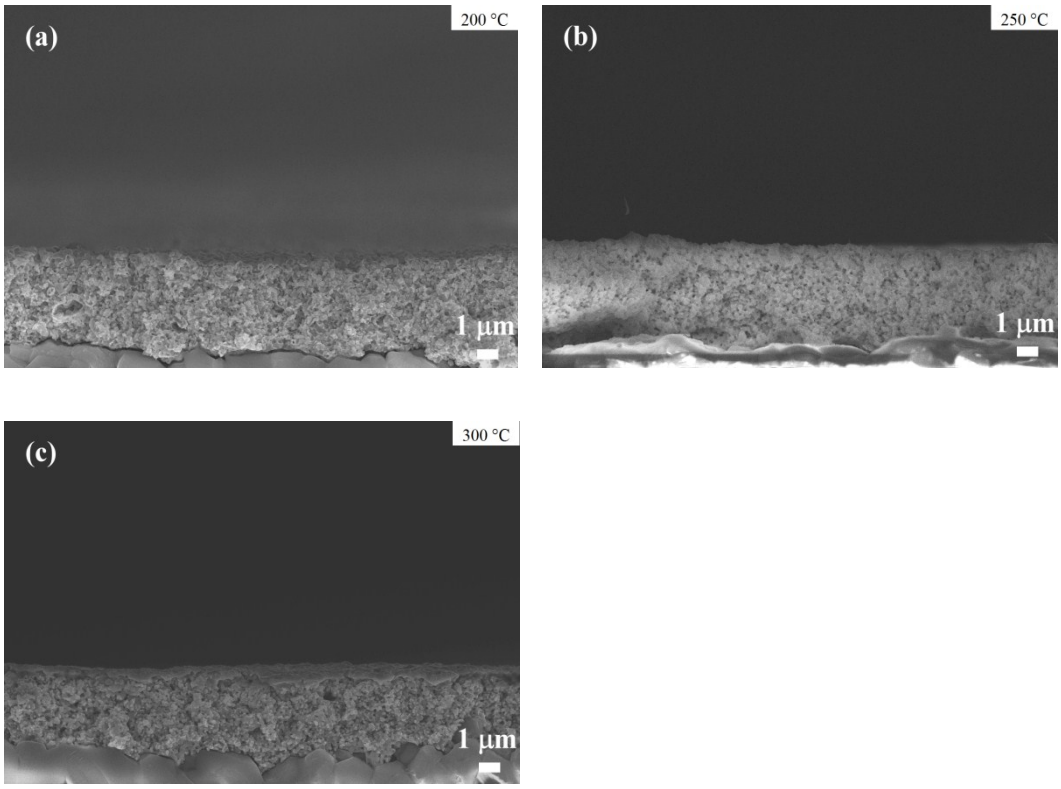

Figure S3 The thicknesses of copper **A** films annealed through a two-step process at various temperatures.

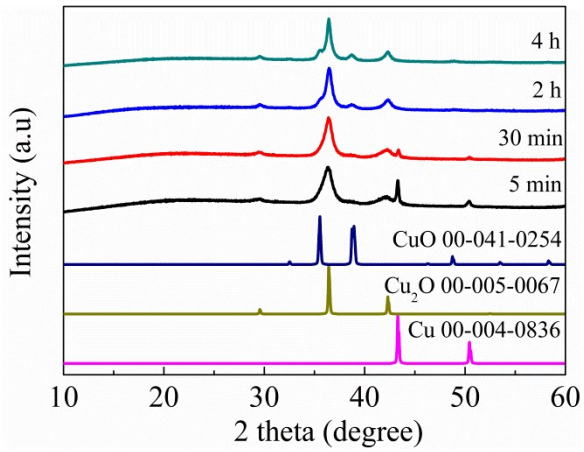

Figure S4 X-ray diffraction patterns of copper **A** films oxidatively preheated at 250 °C for various periods.

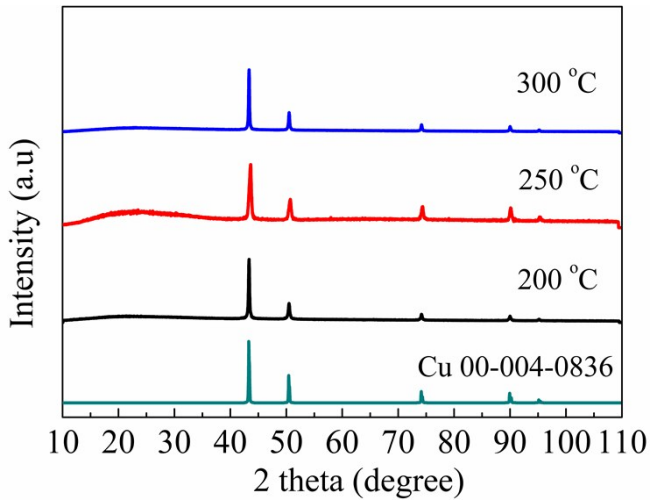

Figure S5 XRD patterns of copper **A** films annealed through a two-step process at 200 °C, 250 °C and 300 °C, respectively.

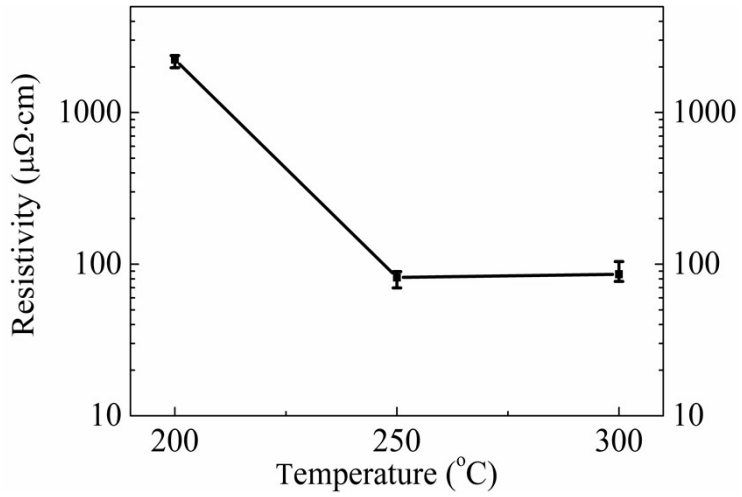

Figure S6 Resistivity as a function of the annealing temperature of copper **B** films annealed through a two-step process.