Supporting Information

Laser Direct Writing and Selective Metallization of Metallic Circuits for Integrated Wireless Devices

Jinguang Cai,[ab] *Chao Lv*[ab] *and Akira Watanabe**[b]

[a] Institute of Materials, China Academy of Engineering Physics, Jiangyou 621908, Sichuan, PR China.

[b] Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, 2-1-1 Katahira, Aoba-ku, Sendai 980-8577, Japan.

*Corresponding authors: caijinguang@foxmail.com; watanabe@tagen.tohoku.ac.jp

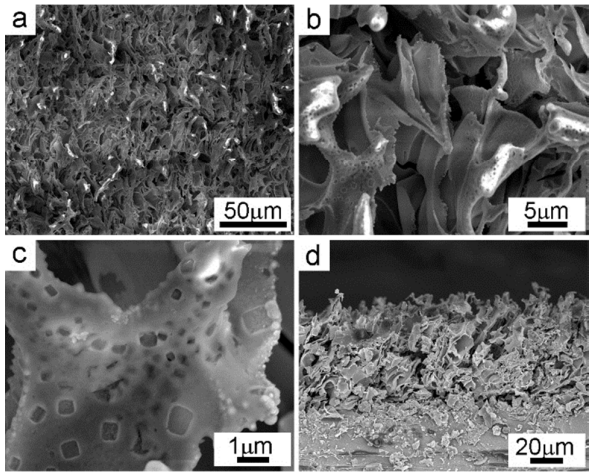

Figure S1. Top-view (a-c) and cross-sectional (d) SEM images of carbon/Pd structures after laser direct writing on a PVP/$PdCl_2$ coated PI film and subsequent cleaning.

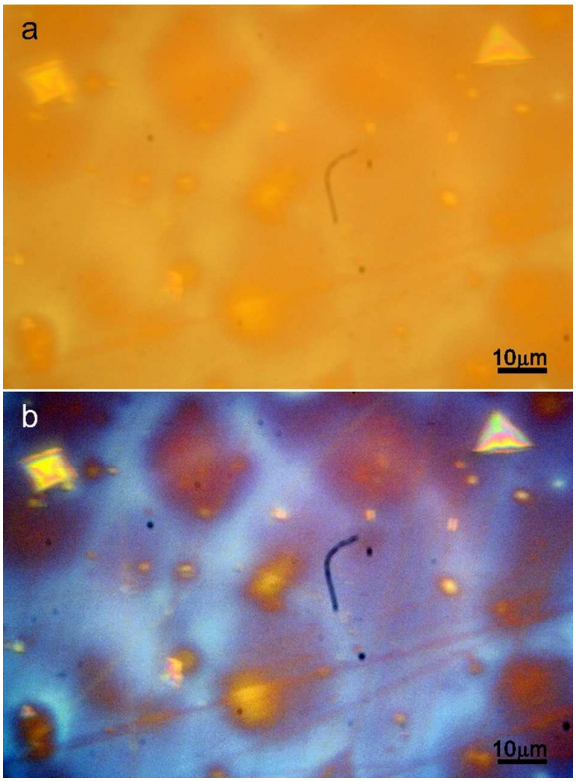

Figure S2. Optical microscopy (OM) image of PVP/$PdCl_2$ layer formed on a polyimide substrate by drop-casting (a), and corresponding image by only tuning the color of the original image to show the $PdCl_2$ micro-crystals clearly (b). The bright parts in the OM image are $PdCl_2$ micro-crystals in micro-meter scale. There may be many $PdCl_2$ crystals located in nanometer area, which cannot be identified by this optical microscope. The black parts are

the dusts in the optical microscope system.

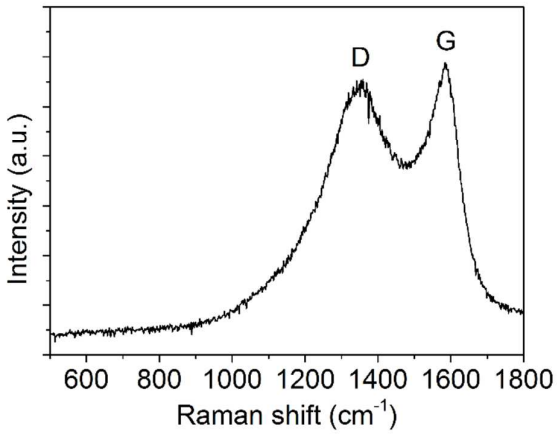

Figure S3. Raman spectrum of the structures obtained after laser direct writing in air on PVP/$PdCl_2$ coated PI film and rinsing.

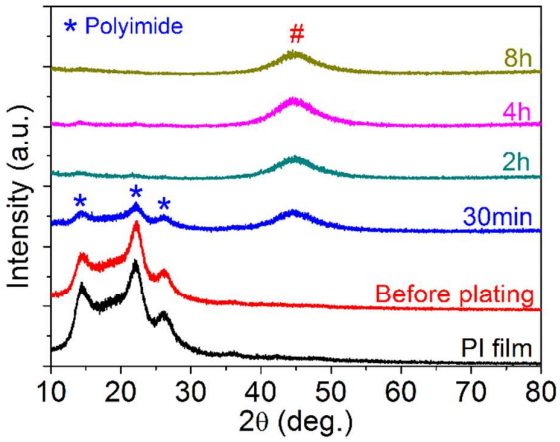

Figure S4. XRD patterns of PI film and the structures before and after electroless Ni plating at 60 ^{o}C for different plating times.

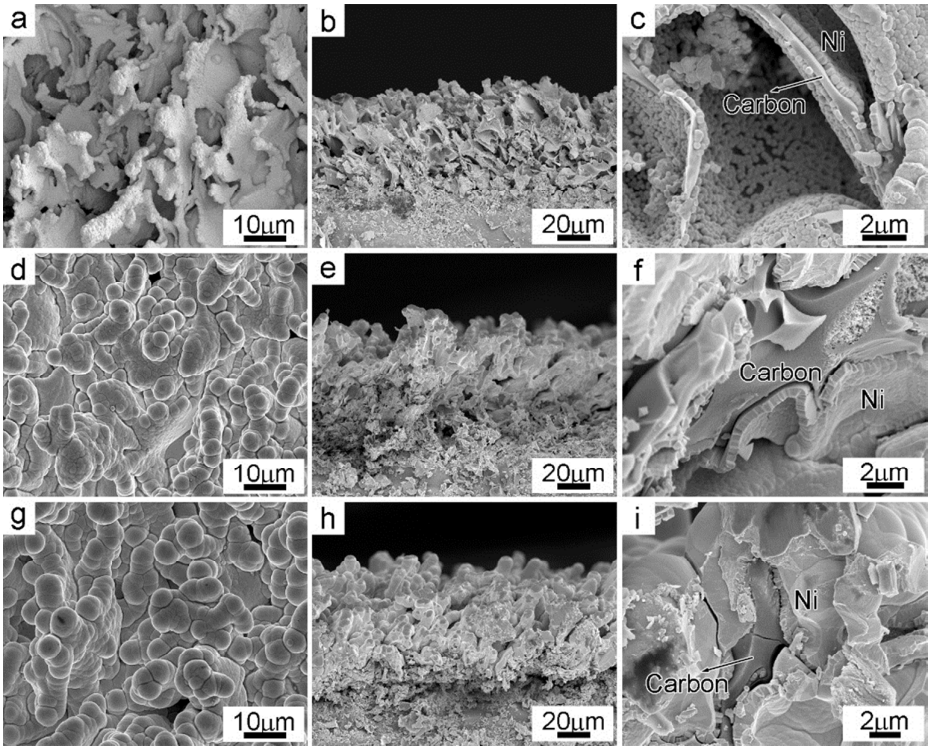

Figure S5. Top-view (a, d, g), cross-sectional (b, e, h), and cracked-part (c, f, i) SEM images of the structures obtained by electroless Ni plating at 60 ℃ at different plating times: (a-c) 30 min, (d-f) 2 h, (g-i) 4 h.

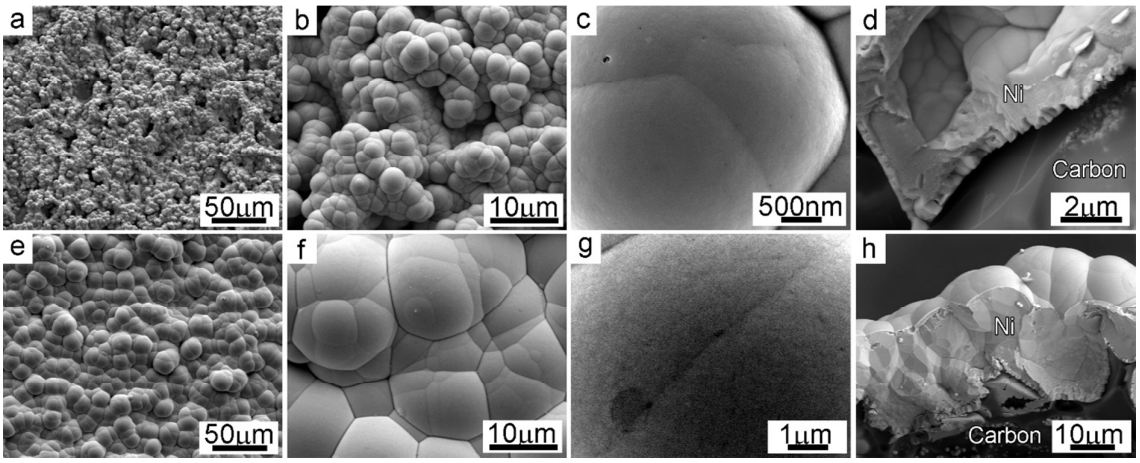

Figure S6. Top-view (a-c, e-g) and cracked-part (d, h) SEM images of the structures obtained by electroless Ni plating at 55 ℃ for 10 hours (a-d) and 65 ℃ for 4 hours (e-h).

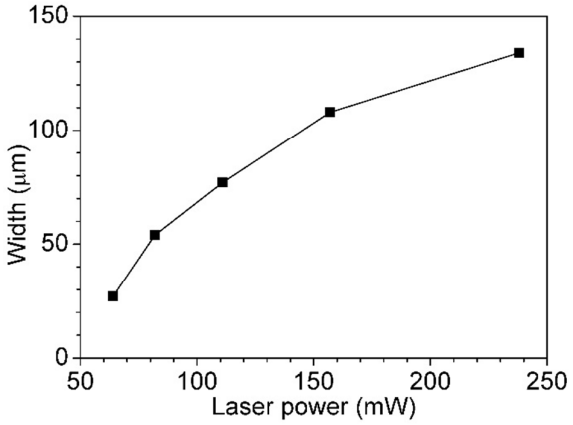

Figure S7. The width of single lines obtained at different laser powers.

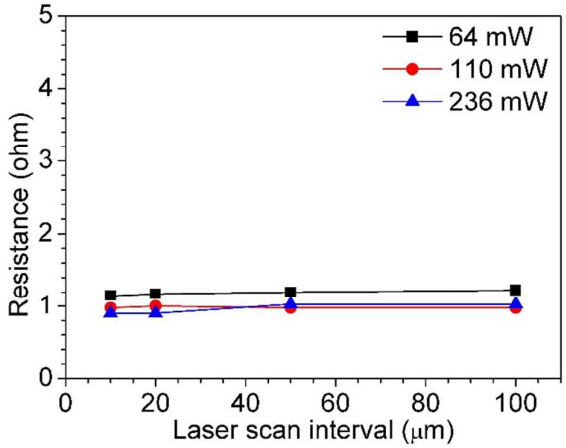

Figure S8. Resistance of carbon/Ni lines with a length of 2 cm and a width of 1 mm obtained by laser direct writing at different laser powers and scan intervals followed by electroless Ni plating at 60 °C for 8 hours.

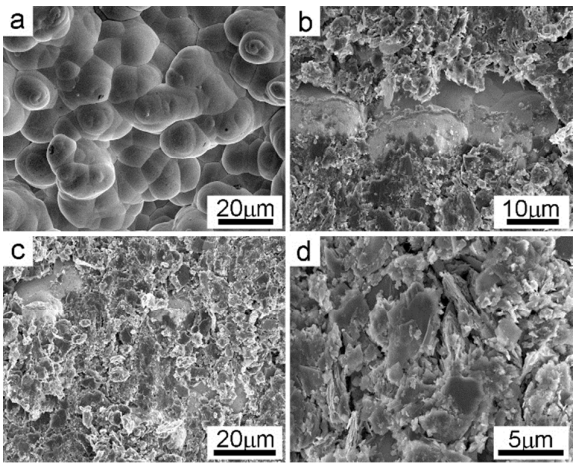

Figure S9. SEM images of the as-prepared carbon/Ni structures (a) and the structures after scratching by a 6H pencil (b-d).

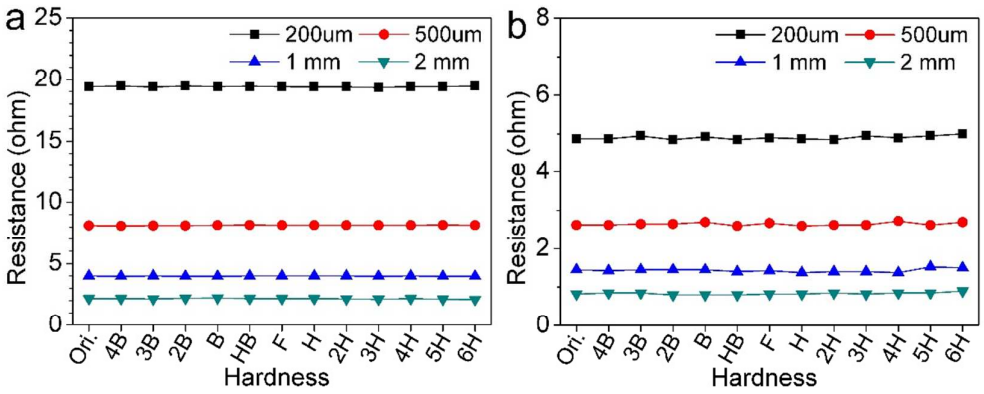

Figure S10. Resistance change of carbon/Ni lines with a length of 2 cm and different widths obtained at different plating conditions after scratching with pencils of different hardness: (a) 55 ℃ for 10 hours, and (b) 65 ℃ for 4 hours.

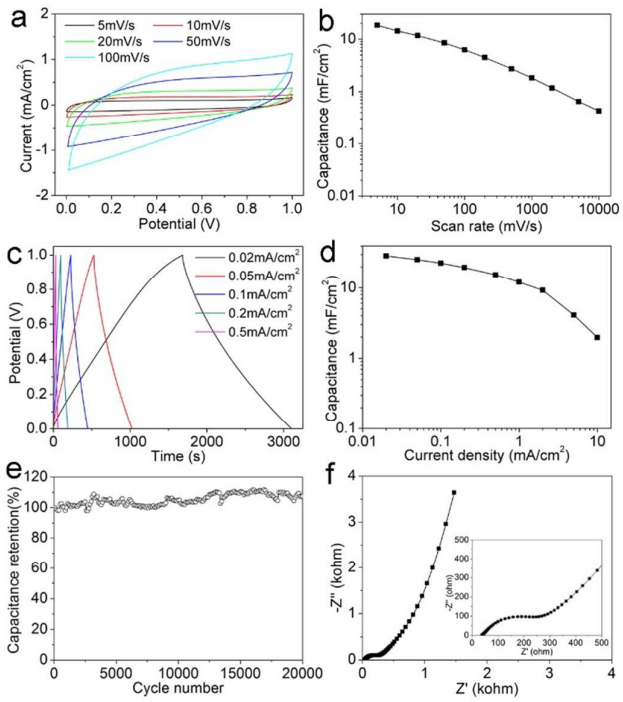

Figure S11. Capacitive performance of the specifically integrated MSC in the wireless device. CV curves of the MSC at different scan rates (a), areal specific capacitances of the MSC calculated from CV curves at different scan rates (b), CC curves of the MSC at different current densities (c), areal specific capacitances of the MSC calculated from CC curves at different current densities (d), cycling stability at a scan rate of 50 mV/s (e), and Nyquist plots of the MSC (f). The inset in (f) shows the high-frequency region of the Nyquist plot.

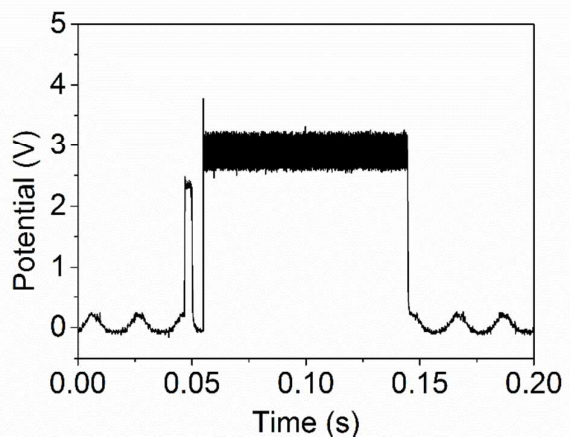

Figure S12. One pulse of 100 ms produced in a period of 5 s from the wireless charger.

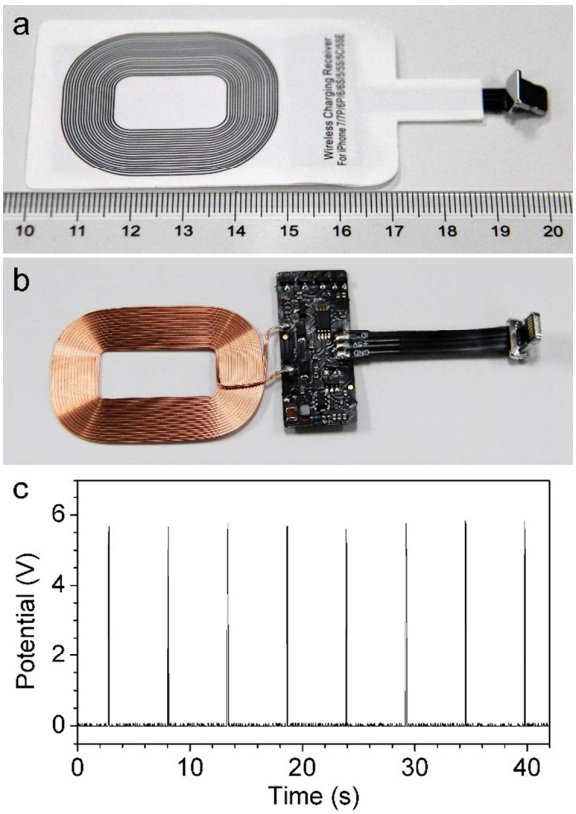

Figure S13. A photograph of a commercial wireless charging receiver (a), a corresponding photograph after removing the package, which indicates that the receiver consists of a copper-wire coil, a control board, and an adapter to connect an iPhone (b), and the pulse potential using the copper-wire coil as a receiver (c).

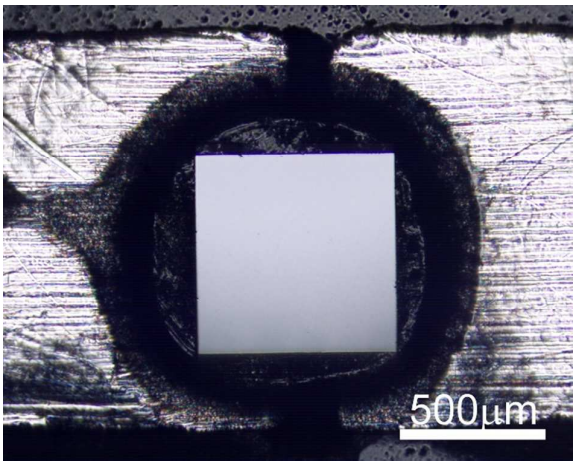

Figure S14. Optical microscopy image of an IC chip, the size of which is only about 700 μm.

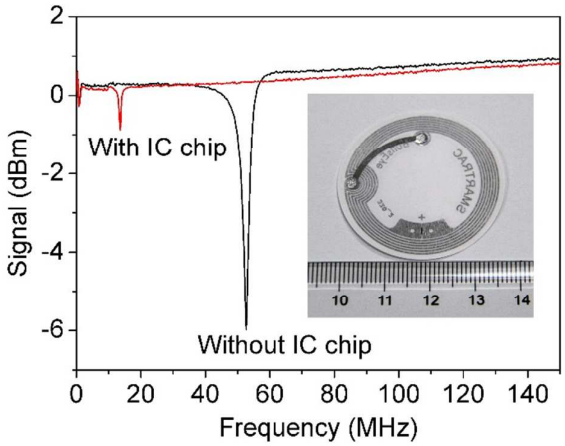

Figure S15. Signal curves of the commercial NFC antenna before and after connecting a commercial IC chip. Inset is a photograph of a commercial NFC tag.