Electrical properties of transferred nano metal pattern using metal oxide release layer method

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Printed electronics (PE) is currently attracting a lot of attention to fabricate flexible and transparent electronic devices. Therefore, fine metal patterning technique for the fabrication of electrodes onto the plastic substrate is critically required and have recently become intensive subjects of research. In addition, three-dimensional (3D) metal pattern, which is used for electric probe, plasmonic devices and patterned media, is also strongly required. In order to fabricate the fine 3D metal pattern effectively and speedy, we have developed the 3D nanoimprint lithography technique using spin on glass (SOG) mold with metal oxide release layer [1, 2]. The fabricated SOG mold surface was initially found to have poor release properties. Thus, chromium or aluminum layer having a thickness of around 20 nm was deposited on a fabricated mold by using a resistively heated vacuum evaporation system (VPC-260F, ULVAC KIKO Inc.). After coating the mold, we ventilated the vacuum evaporation system. Then, the surface of metal layer was oxidized and it was used as a metal oxide release layer. Next, gold, silver or cupper was deposited on the metal release layer. The transfer condition was 80 °C for 30 min, and the polyethylene terephthalate (PET) was used for the transferred substrate. In this study, we examined the electric properties of the transferred metal pattern on the PET substrate.

At first, the sheet resistivity was examined using four-terminal method (101C, Four dimensions Inc.). Figure 1 shows the relationships between the metal thickness and the sheet resistivity. The transferred metal resistivity was similar to the bulk material in thick thickness and the thinner thickness tended to be larger resistivity. In spite of low transfer process temperature, our transferred silver layer has lower resistivity, compared to the silver ink [3]. Next, the breakdown voltage of the nano gap gold pattern on the PET substrate, as shown figure 2, was examined with varying the gap width using micro manipulator (OYM-420FL, THE OYAMA CO., Ltd.) and electrical parameter measuring equipment (4062C, Hewlett-Packard Co.) (see figure 3). The breakdown voltage was decreased according to the shorter gap width and this figure shows the transferred gold pattern is able to use as an electrode. Finally, the current-voltage characteristic of a spattered platinum layer, which has a 150 nm thickness, was examined, as shown figure 4. As a result, the linear characteristics was obtained, thus, the transferred metal pattern fabricated by our transfer process is very useful for the nano-electrode. Additionally, the transistor structure electrode is able to obtain using the 3D metal transferred pattern.

[1] Jun Taniguchi, Shouichi Ide, Noriyuki Unno and Hiroshi Sakaguchi, Microelectronic Engineering 86 (2009) 590

[2] N. Unno, J. Taniguchi, S. Ide, S. Ishikawa, Y. Ootsuka, K. Yamabe, T. Kanbara, J. Phys. Conf. Ser., 191 (2009) 012014.

[3] Jolke Perelaer, Chris E Hendriks, Antonius W M de Laat and Ulrich S Schubert, Nanotechnology (2009) 20 165303

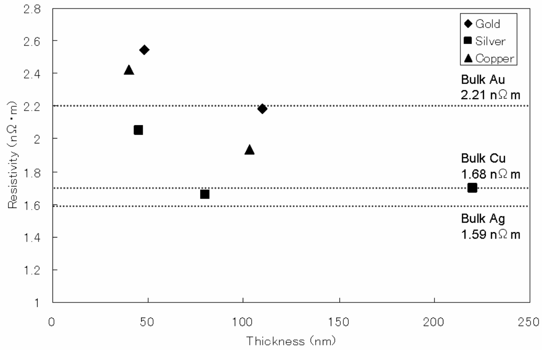

Figure 1 The sheet resistivity of the transferred metal.

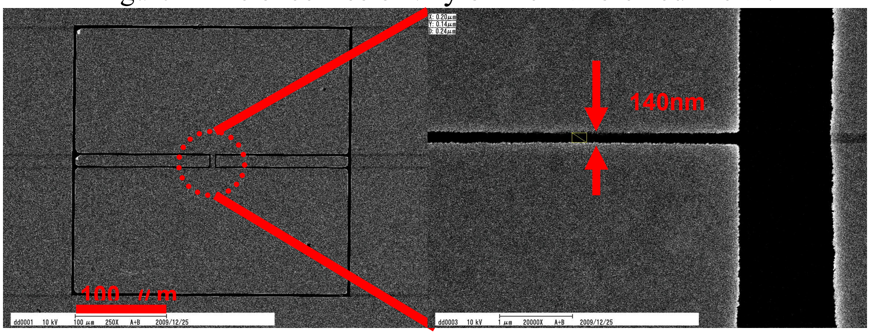

Figure 2 The SEM image of the transferred nano electrodes on PET.

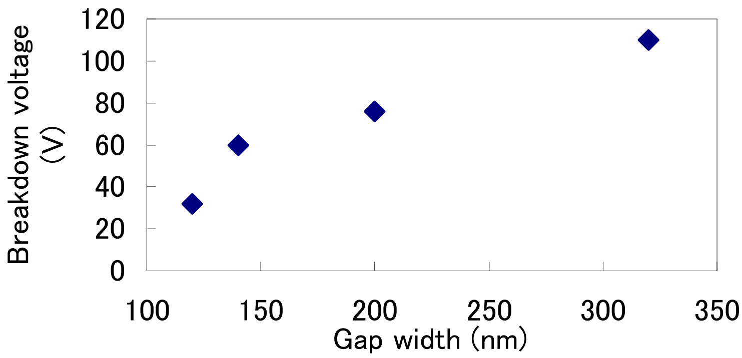

Figure 3 The relationships between the breakdown voltage and the gap width.

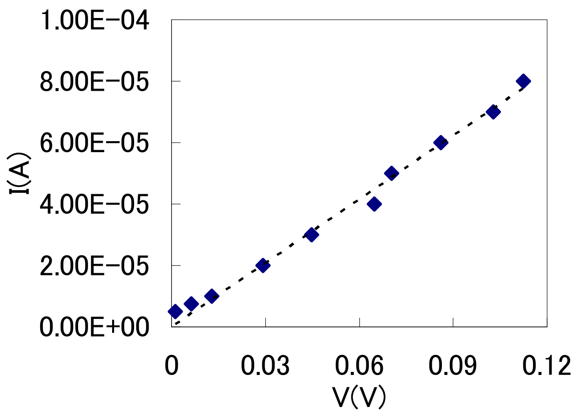

Figure 4 The current-voltage characteristic of a spattered platinum layer.