Stretchable Transparent Capacitive Touch Sensors based on spin-coated Silver-Nanowire composite electrodes

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Silver-nanowire (AgNW) conductive films have been widely studied for replacing indium tin oxide of transparent electrode due to its high conductivity and good transmittance.[1] Recently stretchable electronics are also attractive for touch sensors[2] and displays. In this work, we developed highly stable transparent electrode under stretched environment using simple spin-coated AgNW composite. Additionally, we demonstrated capacitive touch sensors using this stretchable transparent electrodes.

For optimal stretchable electrode, two kinds of AgNW films were compared, thick nanowires with 100nm in diameter and thin nanowire with 30nm. For measuring sheet resistance and transmittance, each AgNW solution was spin-coated on glass substrate with different coating conditions, 1500 rpm for thick nanowire and 1000 rpm for thin nanowire. After spin coating, AgNW films were dried at 100 ^{o}C under nitrogen enviroment, and sheet resistance and transmittance were measured. Thin AgNW films showed better characteristics of 21.35Ω/□ and 92.7% than those of 8.81Ω/□ and 77.4% for thick AgNW films. Thick AgNW films showed low transmittance because thick AgNWs in film reflected the light more than thin AgNWs. For comparison of stretchability, each AgNW film on stretchable polydimethylsiloxane (PDMS) substrates was prepared. Hydrophobic PDMS substrates were plasma-treated by O_2 gas for hydrophilic surface. Other processes of forming AgNW films were the same as on glass substrates. Fig. 1 shows the relative resistances with respect to stretching conditions. Thin AgNW film showed better characteristics compared to thick AgNW film. Thin AgNW has higher aspect ratio of about 800 (25μm in length and 35nm in diameter) than that of 300 (30μm and 100nm) for thick AgNW. Assuming the same young's modulus, stiffness of nanowire is proportional to the cross sectional area of nanowire and inversely proportional to the length. This is the reason why thin nanowire film showed better stretchable characteristics. To enhance the stretchability, polyurethane (PU) solutions were spin-coated on the AgNW films. However, resistances of PU coated samples changed more than those of samples with no PU coating. It is supposed that adhesion of AgNW film on PU film was superior to that on PDMS. The AgNW film was delaminated from PDMS substrate under stretching condition. PDMS surface slowly recovers its hydrophobicity even after long-time O_2 plasma treatment. Modification of surface treament and PU coating condition are under investigation. Nontheless, the film conductance was very stable as shown in Fig. 2.

By using this stretchable transparent electrode, capactive touch sensors are demonstrated.

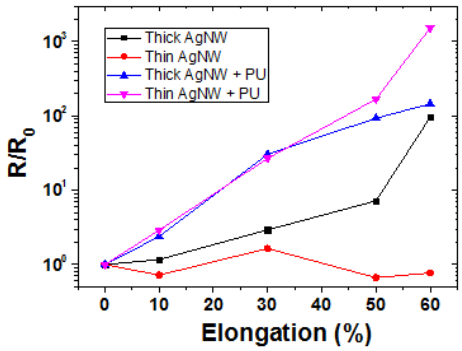

Fig. 1. Resistance changes versus stretching

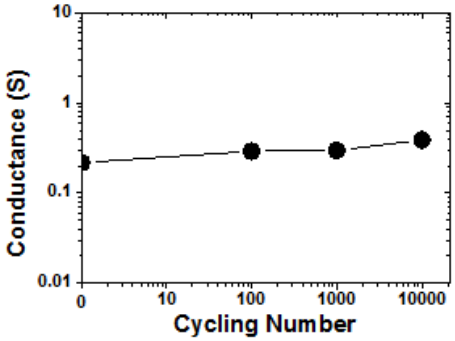

Fig. 2. Conductance after cyclic stretching

References

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