Fabrication of AgNW-SWCNT Hybrid as the Flexible Transparent Film Heater

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Development of silver nanowire (AgNW) and carbon nanotube (CNT) as the active materials for the transparent film heater become the promising substitute material for ITO. AgNW as film possess the comparably optical property and electrical conductivity with those owned by ITO. Unfortunately, AgNW with only tens of nanometers diameter have low melting point which reduce its thermal stability. On the other hand, the high thermal conductivity CNT film is own high thermal stability due to its strong covalent C-C bond. As for the drawbacks, CNT has a higher resistance than ITO or AgNw film. In this study, the advantages of AgNW and CNT are combined by coating SWCNT on AgNW film. It is expected that the locally generated heat produced by AgNW is distributed through the SWCNT layer on the silver. Moreover, highlighting its form as the solution, AgNW and CNT hold the benefit due to their ability to be applied for large area. The composite film fabricated is then analyzed for its optical, thermal, and electrical properties. Single AgNW film is possessing resistance 36.3Ω /sq at the transmittance of 94.4%. This AgNW layer is prepared by deposit the solution on thick glass substrate (5 × 5cm2, 3.2T) using spin coating. Single SWCNT film is prepared by spray coating method of the dispersed aqueous solution on the glass substrate. This film has 600Ω/sq resistance at 91% transmittance. AgNW film showed the high heating characteristic which is able to reach temperature of 54 °C when DC voltage of 8 V is applied. At 16V voltage, this temperature is increased to 140 °C but shows a tendency to decrease rapidly, as the AgNW are damaged by the high heat temperature. SWCNT film with resistance of 38.8Ω / sq in 94.2% transmittance undergoes the temperature change of less than 1 °C at 8 V DC voltages. SWCNT spray coating on AgNW films produce the sheet resistance of 37.8Ω / sq at the transmittance of 85.6%. This composite transparent film showed the stable heating characteristics of ~ 135 ° C temperature change in the DC voltage of 16 V. It is assumed that by dispersing SWCNT, the excellent heat conduction occurs in AgNW may distribute uniformly and increased stability of the film.