Fabrication of Transparent Ultra-thin Single-walled Carbon Nanotube Films for Field Emission Applications

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Abstract : Carbon nanotubes (CNTs) are attractive for field emitter because of their outstanding electrical, mechanical, and chemical properties. Several applications using CNTs as field emitters have been demonstrated such as field emission display (FED), backlight unit (BLU), and X-ray source. In this study, we fabricated a CNT cathode using transparent ultra-thin CNT film. First, CNT aqueous solution was prepared by ultrasonically dispersing purified single-walled carbon nanotubes (SWCNTs) in deionized water with sodium dodecyl sulfate (SDS). To obtain the CNT film, the CNT solution in a milliliter or even several tens of micro-litters was deposited onto a porous alumina membrane through vacuum filtration process. Thereafter, the alumina membrane was solvated by the 3 M NaOH solution and the floating CNT film was easily transferred to an indium-tin-oxide (ITO) glass substrate of 0.5 × 0.5 cm^2 with a film mask. The transmittance of as-prepared ultra-thin CNT films measured by UV-Vis spectrophotometer was 68~97%, depending on the amount of CNTs dispersed in an aqueous solution. Roller activation, which is a essential process to improve the field emission characteristics of CNT films, increased the UV-Vis transmittance up to 93~98%. This study presents SEM morphology of CNT emitters and their field emission properties according to the concentration of CNTs in an aqueous solutions. Since the ultra-thin CNT emitters prepared from the solutions show a high peak current density of field emission comparable to that of the paste-base CNT emitters and do not contain outgassing sources such as organic binders, they are considered to be very promising for small-size-but-high-end applications including X-ray sources and microwave power amplifiers.

Key Words : carbon nanotube, field emission, transparent film, sodium dodecyl sulfate