Thermal annealing effect on field emission properties of double-walled carbon nanotubes

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Three kinds of double-walled carbon nanotubes (DWCNTs) were synthesized using a catalytic CVDand a hydrogen arc discharge method. In order to grow DWCNTs by catalytic CVD, methane and THF were used as acarbon source. To synthesize DWCNTs by arc discharge, Fe catalyst and FeS promoter were used in hydrogen ambient. The as-synthesized DWCNTs were purified using a thermal oxidation in air ambient at 400℃and acid treatment at room temperature. After purification, some of DWCNTs was further treated using high temperature annealing at 1300℃ in the vacuum chamber of 10^{-5} Torr in order to improve the crystallinity of DWCNTs.

Field emitters were fabricated on planar silicon substrates using the purified and the annealed DWCNT samples. The field emission properties showed that the emission performance of the DWCNTs grown using CVD was improved significantly after the high temperature annealing, while that of the DWCNTs synthesized using arc discharge was almost the same. The improvement of field emission performance of the CVD DWCNTs can be explained by the fact that the crystallinity of CVD DWCNTs is enhanced after the high temperature annealing. On the other hand, the emission properties of arc discharge DWCNTs reveals that the change of crystallinity of DWCNTs is negligible after the high temperature annealing because the arc discharge DWCNTs were synthesized at a high temperature.