Study on the Growth Mechanism of the Carbon Nanotubes Synthesized at Low Temperatures Using Multilayered Catalytic Films

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Abstract

Simple thermal catalytic-CVD method via careful selection of the interlayer is be chosen on which the thin catalyst layer is deposited, it was found that the interlayer can tune the shapes and sizes of the catalyst particles, which are controlled by the relative surface energies of the interlayer. Previously, efforts have been made to optimize CNTs growth process by adding a metal multilayer below the catalyst layer, then, synthesized the carbon nanotubes at low temperature via specified interlayer with suitable surface energy. The mechanism of the metal catalyst in the formation of the nanoutbes at low temperature has been completely clarified and showed the superior field emission characteristics. Under the proofs of many experimental results,

multilayer catalyst films possessed the above advantages. Especially the 20A Co/30A Cr/100A Al and 20A Co/30A Ti/100A Al were the best candidates for multilayer catalyst film , first at 550℃ including low turn on field (3.71V/um)/(3.5V/um) and high current density (18.24mA/cm^2)/ (28.6mA/cm^2) , then, at 500℃ low turn on field (4.03V/um)/(3.875V/um) and high current density (4.16mA/cm^2)/ (3.41mA/cm^2) by each, Additionally, there were show great performance no matter the reliability and field emission properties, which exceeded 10 mA/cm^2 after 1 hrs stress test. For the gated controlled triode structure, the whole structures were fabricated at 550℃ and 500℃. By controlling the depth of side etching of metal gate and the length of CNTs, the ability of increasing anode currents and reducing gate leakage currents could be realized. Besides, the improvement of gate controlled anode current CNT-triodes was proposed and characterized, and the insulated gate structure field emission triodes can avoid the short circuit problem between cathode and gate.

Finally, CNTs were grown on sodalime glass substrate at low temperature by utilizing multilayer catalyst films as described above and the excellent field emission properties could be obtained, which exceeded 20 mA/cm^2 after 1 hr's stress test.

The uniform CNT films were grown successfully at low temperature with the multilayer catalyst films by thermal CVD. Simultaneously, CNTs were grown on glass substrate for the application of field emission display. We think that the field emission display will be developed if a proper gate structure is combined with the glass substrate. And we expect that a large size field emission display with higher resolution will be fabricated in the future.