Chapter 5 Conclusions

By manipulating nanofabrication parameters to synthesize well-aligned carbon nanotubes and carbon nanocones are successfully approached on MPCVD method. First, to obtain uniform average particle sizes and appropriate number density of Co catalyst, the hydrogen plasma pretreatment temperature should keep below 600 ℃. The greater pretreatment substrate temperature is corresponding to the greater gas pressure and microwave power. Further, under greater self-bias, applied bias and growth number density were speculated the factors for synthesized well-aligned CNTs. The precursor gases have heavier ion mass as like NH_3 and Ar are more helpful and useful to enhance the self-bias of plasma. Applied greater bias also can enhance the potential of the plasma sheath to induce the well-aligned CNTs growth and arise the SP^2 bonding of CNTs. The greater tube number density of CNTs can also induce alignment of CNTs by neighbor supporting each other. The best FE properties of well-aligned CNTs exhibit E_{to}~ 4.4 V/μm, E_{th} ~ 8.26 V/μm, β ~ 4069 and J ~ 88.7 mA/cm^2 at 10 V/μm, which synthesized under NH_3 +C_2H_2 source gases without applied bias and post plasma pretreatment for 10 min growth. Proper defects of CNTs are speculated to enhance the FE properties. However, the worse stability of the CNTs is resulted by bad adhesion between the substrate.

The well-aligned CNCs prefer to synthesize under greater applied bias (above -150 V) and higher H_2/CH_4 ratio (over 80/5). The morphologies of CNCs are strongly

depending on the applied bias and H_2/CH_4. The structure of CNCs can be considered as mixture of single crystal Co, polycrystalline graphite, amorphous Si and amorphous carbon. The best FE properties of well-aligned CNCs were synthesized under H2+CH_4 (80/5 sccm) source gases with applied -300 V bias for 10 min growth. It exhibit E_{to}~ 5.0 V/μm, E_{th} ~ 6.99 V/μm, β ~ 4993, and J ~ 173.42.7 mA/cm^2 at 10 V/μm. moreover, it also show the significant stability of field emission than well-aligned CNTs. Hence, it is expected having a greater potential of field emission applications.