Pretreatment of Catalyst Metal by N2 and CF4 Plasma and Their Effects on the Growth of SiOx Nanowires

賴威君、李世鴻

E-mail: 9707391@mail.dyu.edu.tw

ABSTRACT

In this work, a layer of 5nm nickel was evaporated onto a (100) silicon substrate and then pre-treated with nitrogen (N2) and tetrafluoromethane (CF4) plasma. Subsequently, SiOx nanowires were synthesized with in a furnace at 1000 ° C and an argon flow rate of 500sccm by SLS mechanism. Scanning electron microscope (SEM), energy dispersive spectrometer (EDS), Fourier transform infrared spectroscopy (FTIR) and field emission were employed to study the influence of these two plasma pre-treatments of Ni on the growth of SiOx nanowire. It is found that as the plasma RF power is increased, the nickel particles become smaller and the number of nickel particles become higher in the nucleation stage. Accordingly, the diameter of synthesized SiOx nanowire become smaller and the number of SiOx nanowires become higher. Hence, the field emission of SiOx nanowire is enhanced. In addition, the bigger aspect ratio of SiOx nanowire and the smaller curvature radius at the tip also make the emission current increase. After 900W of N2 plasma pretreatment, the emission current of synthesized SiOx nanowire reached 1110 μ A/cm2, from 86 μ A/cm2 of untreated; and after 700W of CF4 plasma pretreatment, the emission current is 2100 μ A/cm2. However, high-power CF4 plasma pretreatment may hinder the nucleation of nickel catalyst which can suppress the growth of SiOx nanowires. Experimental results reveal that 700W of CF4 plasma pretreatment on the nickel catalyst has a most pronounced effect on the enhancement of field emission characteristics of SiOx nanowire.energy dispersive spectrometer (EDS), Fourier transform infrared spectroscopy (FTIR) and field emission were employed to study the influence of these two plasma pre-treatments of Ni on the growth of SiOx nanowire. It is found that as the plasma RF power is increased, the nickel particles become smaller and the number of nickel particles become higher in the nucleation stage. Accordingly, the diameter of synthesized SiOx nanowire become smaller and the number of SiOx nanowires become higher. Hence, the field emission of SiOx nanowire is enhanced. In addition, the bigger aspect ratio of SiOx nanowire and the smaller curvature radius at the tip also make the emission current increase. After 900W of N2 plasma pretreatment, the emission current of synthesized SiOx nanowire reached 1110 μ A/cm2, from 86 μ A/cm2 of untreated; and after 700W of CF4 plasma pretreatment, the emission current is 2100 μ A/cm2. However, high-power CF4 plasma pretreatment may hinder the nucleation of nickel catalyst which can suppress the growth of SiOx nanowires. Experimental results reveal that 700W of CF4 plasma pretreatment on the nickel catalyst has a most pronounced effect on the enhancement of field emission characteristics of SiOx nanowire.

Keywords : SiOx nanowires ; plasma pre-treatments ; field emission ; metal-induced precipitation ; Si-Ni alloy

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