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Investigation of field emission properties of SiC nanowires and their applications in flexible field emission displays

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Introduction

Silicon carbide (SiC) as a significant third-generation semiconductor material, with wide band gap (2.2-3.3 eV), high thermal stability, high electrical and thermal conductivities, which is considered as one of the most promising materials for the potential application in the field of field emission devices. In this study, SiC nanowires can be transferred and fabricated in form of paste, aiming to achieve the good field emission performances with both high emission stability and low turn-on field.

EXPERIMENTAL DETAILS

Firstly, SiC nanowires were prepared by using a thermal evaporation process based on the silicon powder precursor in an upright graphite furnace presented. Secondly, the SiC nanowire emitters were transferred onto a stainless-steel cylinder substrate with conductive and flexible adhesive tape.

Results

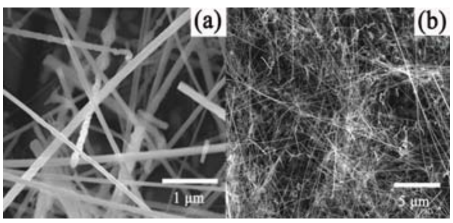

Figure.1 SEM images of the grown SiC nanowires. (a) higher and (b) lower resolution

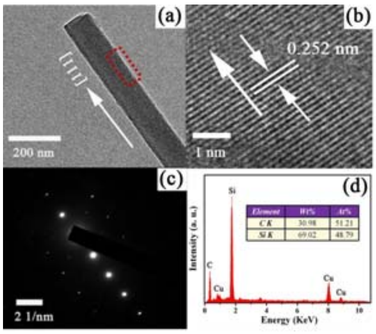

Figure 2 (a) Low-magnification TEM image. (b) HRTEM image. (c) SAED pattern. (d) EDX result of the single SiC nanowires

The TEM image indicate the single-crystalline nature of a single SiC nanowires. The interplanar spacing d of two neighbored lattice fringes is about 0.252 nm, corresponding to the d-spacing of the (111) plane in β-SiC. This suggested that the growth direction of nanowires is [111] direction. The energy dispersive X-ray spectroscopy (EDX) result from Fig. 2(d) reveals that the nanowire consists of Si and C elements with an atomic ratio close to 1:1, confirming that the nanowire is SiC.

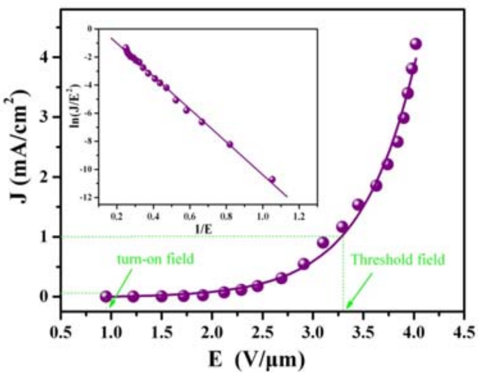

Figure 3. J-E plot of the flexible SiC nanowires. The upper left corner inset is the corresponding F-N curve.

The field emission properties of the flexible SiC nanowire emitters were demonstrated in Fig. 4. It is clear that the SiC emitters have the turn-on field (J = 10 μA/cm2) of ~0.95 V/μm, and the threshold field (J = 1 mA/cm2) of ~3.26 V/μm. The excellent experimental results are mainly due to the low work function and the high aspect ratio of the axially grown nanowires.

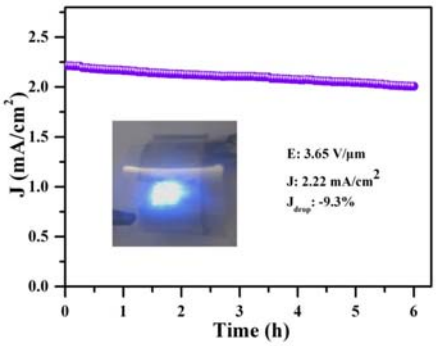

Figure 4 Field emission current density stable characteristics of the flexible SiC nanowire emitters at 3.65 V/μm. The inset shows the corresponding photographic image of the flexible FE display

Conclusion

We have presented the fabrication of the SiC nanowires by the thermal evaporation method and the flexible SiC nanowire emitters show remarkable FE characteristics. The flexible field emission devices fabricated with the SiC nanowire emitters displayed homogeneous and bright emission modes. It is worth mentioning that the emission current is highly stable with almost constant data throughout test period and there are no signs of degradation under flexible displays.