Electronic Supplementary Information

Synthesis of β-SiC nanowires via a facile CVD method and their photoluminescence properties

Silin Liu,[a] Haitao Liu,[a] Zhaohui Huang,*[a] Minghao Fang,[a] Yan-gai Liu,[a] and Xiaowen Wu[ab]

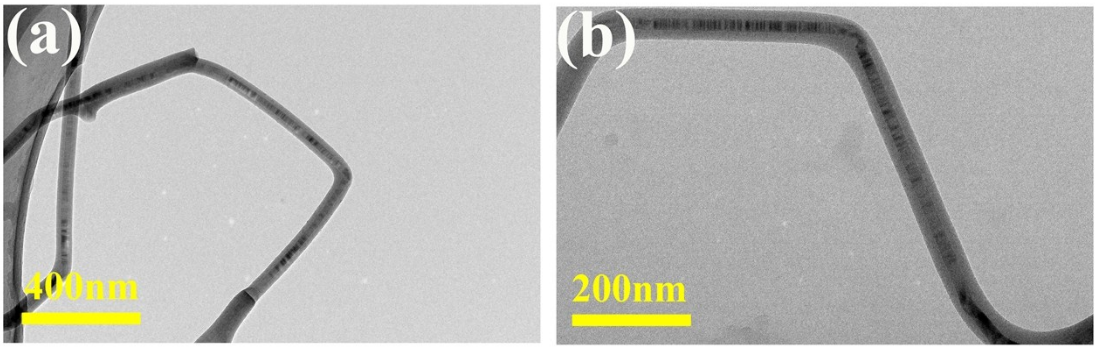

Fig. S1 (a) and (b) typical low TEM images of as-grown SiC nanowires

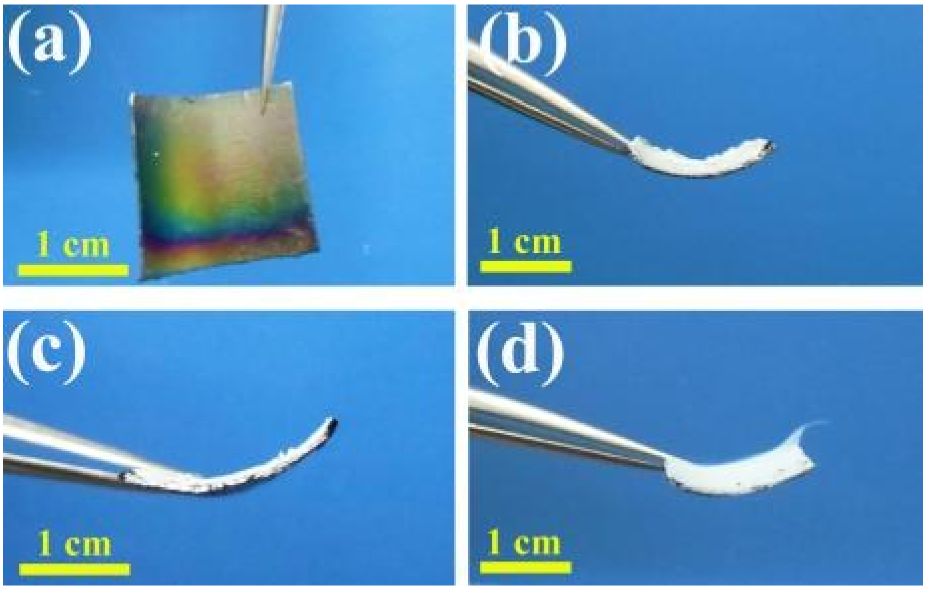

Fig. S2 (a) Digital camera picture of the graphite felt when heating at 1200 ^{o}C, (b) Digital camera picture of wool-like products grown on the surface of graphite felt when heating at 1400 ^{o}C, (c) at 1500 ^{o}C, (d) when synthesized with $Ni(NO_3)_2$ as catalyst heating at 1300 ^{o}C.

The discussion of the changing gas compositions in our CVD procedure

An enclosed corundum crucible (10 ml) was used in our study. Before the furnace temperature was elevated, no evacuated control was conducted. It means that the pressure of residual air was 1×10^5 Pa. According to the composition of the air, the partial pressure of residual oxygen (p_{O_2}) in the furnace was about 2.1×10^4 Pa, the partial pressure of residual nitrogen (p_{N_2}) in the furnace was about 7.8×10^4 Pa.

According to the equation of state of ideal gas:

$$pV = n\mathrm{R}T \tag{1}$$

We can obtain the following formula (2):

$$pV\mathrm{M} = m\mathrm{R}T \tag{2}$$

It can be expressed as:

$$m = \frac{pV\mathrm{M}}{\mathrm{R}T} \tag{3}$$

So, under the above-mentioned state (p_{O_2}=2.1×10^4 Pa, T^θ=298.15K), the mass of residual oxygen ($m^\theta_{O_2}$) can be calculated by the following formula (4):

$$m^\theta_{O_2} = \frac{p_{O_2}V\mathrm{M}_{O_2}}{\mathrm{R}T^\theta} = \frac{2.1\times10^4\,\mathrm{Pa}\times(10\times10^{-6})\ \mathrm{m}^3\times32\mathrm{g}\cdot\mathrm{mol}^{-1}}{8.314\mathrm{m}^3\cdot\mathrm{Pa}\cdot\mathrm{mol}^{-1}\cdot\mathrm{K}^{-1}\times298.15\mathrm{K}}$$

$$= 2.71\times10^{-3}\,\mathrm{g} \tag{4}$$

This means that, before the furnace was elevated to higher temperatures, there is still a certain amount of residual oxygen existing in the furnace.

However, at high temperatures, the gas compositions in the furnace will become very complicated. On the one hand, when the temperature rose gradually, the surviving oxygen (O_2 and H_2O) in the furnace will react with the charred coal particles to yield CO vapor. Then SiO and CO_2 vapor were generated by the reaction of the SiO_2 layer on the surface of the Si substrate with CO vapor. The generated CO_2 vapor will also react with carbon to re-generate CO vapor. During the above-mentioned reaction processes, oxygen was consumed gradually, while CO was generated firstly, then consumed and re-generated.

During the synthesis process, the total pressure of reaction system (p_{sum}) is the sum of the partial pressure of each component:

$$p_{\mathrm{sum}} = p_{\mathrm{N_2}} + p_{\mathrm{O_2}} + p_{\mathrm{CO}} + p_{\mathrm{CO_2}} + \cdots \quad (5)$$

The partial pressure (supersaturation) of CO is much higher than that value in Ar flowing system. This means that the nucleation and growth kinetics of the SiC nuclei and nanowires are higher than previous Ar flowing systems.