ESI: ELECTRONIC SUPPLEMENTARY INFORMATION

An Analytical Model for the Bending of Radial Nanowire Heterostructures†

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1. The calculation of the total strain energy

The inserting Eqs. (3) and (4) into Eq. (5) in the main body, calculation of the total strain is as follows:

$$E_{str}=\int_{-r-h_2}^{r+h_1}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy$$

$$=\int_{-r-h_2}^{-r}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy+\int_{-r}^{r}\left[\frac{c_{11}}{2}\epsilon_z^2\right]dy+\int_{r}^{r+h_1}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy \tag{S1}$$

In different positions of NW heterostructures, ϵ_x and ϵ_z are expressed differently, which can be divided into the following three types:

when $h_1>r_0-r$ and $h_2>r_0-r$

$$E_{str}=\int_{-r-h_2}^{r+h_1}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy$$

$$=\int_{-r-h_2}^{-r_0}\frac{c_{11}}{2}(\epsilon_m+\epsilon_1+Ky)^2dy+\int_{-r_0}^{-r}\frac{c_{11}}{2}[\epsilon_x^2+(\epsilon_m+\epsilon_1+Ky)^2]+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy$$

$$+\int_{-r}^{r}\frac{c_{11}}{2}(\epsilon_1+Ky)^2dy+\int_{r}^{r_0}\frac{c_{11}}{2}[\epsilon_x^2+(\epsilon_m+\epsilon_1+Ky)^2]+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy$$

$$+\int_{r_0}^{r+h_1}\frac{c_{11}}{2}(\epsilon_m+\epsilon_1+Ky)^2dy$$

$$=c_{11}\epsilon_1^2r+\frac{c_{11}(\epsilon_0+\epsilon_1)^2}{2}(h_1+h_2)+\frac{c_{11}(\epsilon_0+\epsilon_1)K}{2}(2r+h_1+h_2)(h_1-h_2)$$

$$+\frac{c_{11}K^2}{6}[(r+h_1)^3+(r+h_2)^3]+c_{11}A-2c_{12}(\epsilon_0+\epsilon_1)A+c_{12}(\epsilon_0+1)(\epsilon_0+\epsilon_1)B$$

$$-c_{11}(\epsilon_0+1)B+\frac{c_{11}(\epsilon_0+1)^2}{3}C+\frac{c_{12}K}{2}D+\frac{c_{12}(\epsilon_0+1)K}{3}E \tag{S2}$$

In this formula, $A=(r_0-r)$, $B=\frac{r_0^2-r^2}{r}$, $C=\frac{r_0^3-r^3}{r^2}$, $D=0$, $E=0$.

when $h_1\geq r_0-r$ and $h_2\leq r_0-r$

$$E_{str}=\int_{-r-h_2}^{r+h_1}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy$$

$$=\int_{-r-h_2}^{-r_0}\frac{c_{11}}{2}(\epsilon_m+\epsilon_1+Ky)^2dy+\int_{-r_0}^{-r}\frac{c_{11}}{2}[\epsilon_x^2+(\epsilon_m+\epsilon_1+Ky)^2]+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy$$

$$+\int_{-r}^{r}\frac{c_{11}}{2}(\epsilon_1+Ky)^2dy+\int_{r}^{r_0}\frac{c_{11}}{2}[\epsilon_x^2+(\epsilon_m+\epsilon_1+Ky)^2]+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy$$

$$+\int_{r_0}^{r+h_1}\frac{c_{11}}{2}(\epsilon_m+\epsilon_1+Ky)^2dy$$

$$=c_{11}\epsilon_1^2r+\frac{c_{11}(\epsilon_0+\epsilon_1)^2}{2}(h_1+h_2)+\frac{c_{11}(\epsilon_0+\epsilon_1)K}{2}(2r+h_1+h_2)(h_1-h_2)$$

$$+\frac{c_{11}K^2}{6}[(r+h_1)^3+(r+h_2)^3]+c_{11}A-2c_{12}(\epsilon_0+\epsilon_1)A+c_{12}(\epsilon_0+1)(\epsilon_0+\epsilon_1)B$$

$$-c_{11}(\epsilon_0+1)B+\frac{c_{11}(\epsilon_0+1)^2}{3}C+\frac{c_{12}K}{2}D+\frac{c_{12}(\epsilon_0+1)K}{3}E \quad \text{(S3)}$$

In this formula, $A=(h_2+r_0-r)$, $B=\frac{(r+h_2)^2+r_0^2-2r^2}{2r}$, $C=\frac{(r+h_2)^3+r_0^3-2r^3}{2r^2}$, $D=(r+h_2)^2-r_0^2$, $E=\frac{r_0^3-(r+h_2)^3}{r}$.

when $h_1\le r_0-r$ and $h_2\le r_0-r$

$$E_{str}=\int_{-r-h_2}^{r+h_1}\left[\frac{c_{11}}{2}(\epsilon_x^2+\epsilon_z^2)+c_{12}\epsilon_x\epsilon_z\right]dy$$

$$=\int_{-r-h_2}^{-r}\frac{c_{11}}{2}[\epsilon_x^2+(\epsilon_m+\epsilon_1+Ky)^2]+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy+\int_{-r}^{r}\frac{c_{11}}{2}(\epsilon_1+Ky)^2dy$$

$$+\int_{r}^{r+h_1}\frac{c_{11}}{2}(\epsilon_m+\epsilon_1+Ky)^2+c_{12}\epsilon_x(\epsilon_m+\epsilon_1+Ky)dy$$

$$=c_{11}\epsilon_1^2r+\frac{c_{11}(\epsilon_0+\epsilon_1)^2}{2}(h_1+h_2)+\frac{c_{11}(\epsilon_0+\epsilon_1)K}{2}(2r+h_1+h_2)(h_1-h_2)$$

$$+\frac{c_{11}K^2}{6}[(r+h_1)^3+(r+h_2)^3]+c_{11}A-2c_{12}(\epsilon_0+\epsilon_1)A+c_{12}(\epsilon_0+1)(\epsilon_0+\epsilon_1)B$$

$$-c_{11}(\epsilon_0+1)B+\frac{c_{11}(\epsilon_0+1)^2}{3}C+\frac{c_{12}K}{2}D+\frac{c_{12}(\epsilon_0+1)K}{3}E \quad \text{(S4)}$$

In this formula, $A=(h_1+h_2)$, $B=\frac{(r+h_1)^2+(r+h_2)^2-2r^2}{2r}$, $C=\frac{(r+h_1)^3+(r+h_2)^3-2r^3}{2r^2}$, $D=(r+h_2)^2-(r+h_1)^2$, $E=\frac{(r+h_1)^3-(r+h_2)^3}{r}$.

2. Theoretical analysis of the InAs/GaAs systems.

We use the following parameters to perform a theoretical calculation of the InAs/GaAs system. In our calculations, $c_{11}=8.34\times10^{11}dyn/cm^2$, $c_{12}=4.54\times10^{11}dyn/cm^2$,

ε_m=6.7% , γ_{InAs}=13.75eV/nm^2 , γ_{GaAs}=8.75eV/nm^2 . [1] Based on the theoretical calculation of InAs/GaAs, it was found that the InAs/GaAs system is easier to bend (that is, the *K* is larger) than Ge/Si system under the same radius and the same deposition amount.

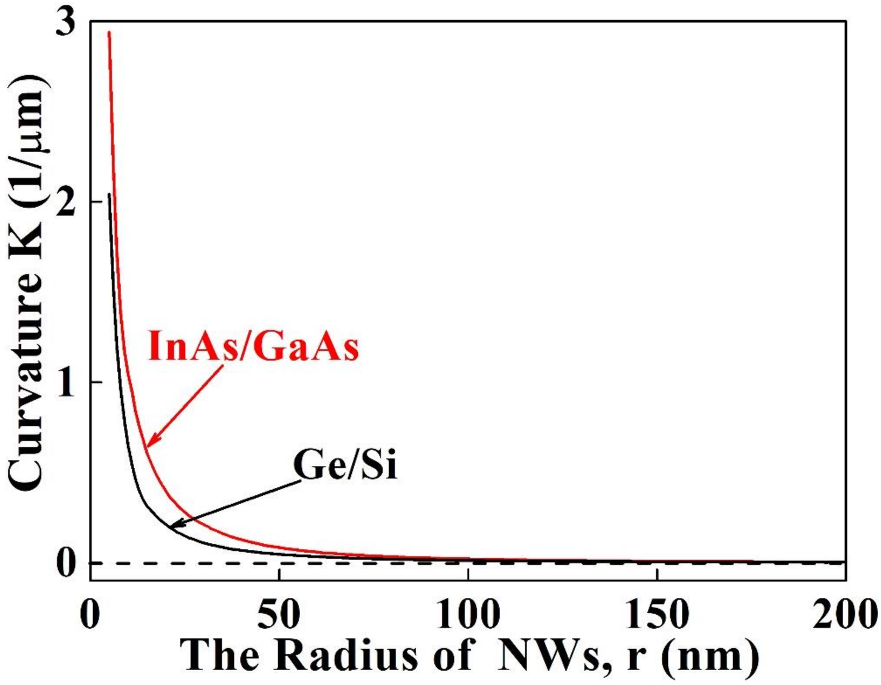

Fig. S1 The relation between the curvature of NWs (GaAs NWs or Si NWs). Red line indicates InAs/GaAs system, black line indicates Ge/Si systems.

References

1 X. L. Li, Y. Y. Cao and G. W. Yang, *Physical Chemistry Chemical Physics*, 2010, **12**, 4768.