SUPPORTING INFORMATION

Misfit-guided self-organization of anti-correlated Ge quantum dot arrays on Si nanowires

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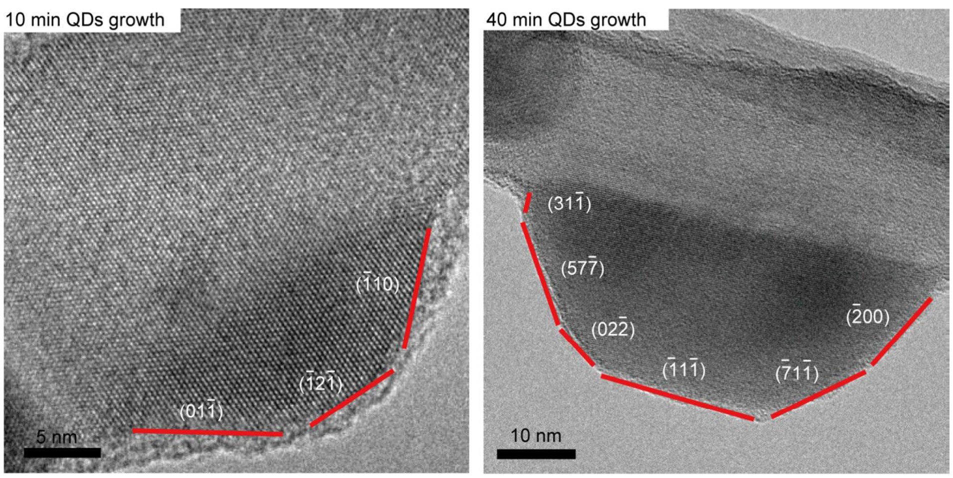

Fig. S1 TEM images at two different Ge deposit time showing time evolution behavior of Ge QDs. As Ge deposition increases, Ge QDs grow taller and wider with increased number of facets.

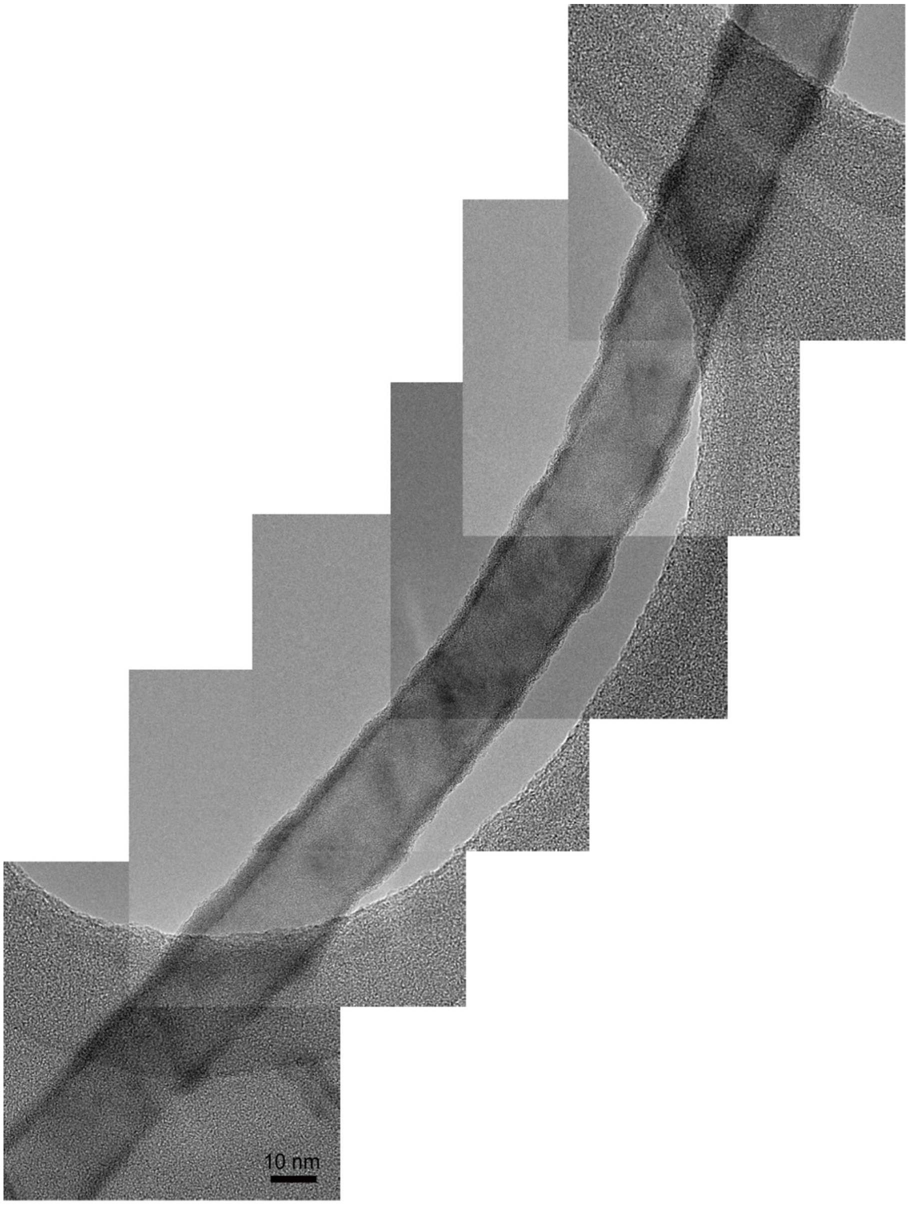

Fig. S2 A series of TEM images of uniform Ge shell deposition along the 320 nm long Si core. The measured shell thickness is 2±0.6 nm.

Calculation of the wavelength of Ge QD arrays as a function of core diameter and thermodynamic activation energy of Ge adatoms surface diffusion

Perturbation of radius takes the form of $R = R_s + \delta\, cos(qz)\, cos(n\phi)$ where R_s is the outer radius of the unperturbed core-shell nanowire, δ is the amplitude of the perturbation, q and n is the wavenumber in the axial and circumferential direction. The time dependent perturbation can be expressed as[1]

$$\dot{\delta} = \frac{D_S \Gamma\, \Omega^2\, \gamma}{kT}\left(\frac{n^2}{R_S^2} + q^2\right)\left(\frac{1-n^2}{R_S^2} - q^2 - \frac{\Delta\omega}{\gamma}\right)\delta \quad (1)$$

where D_s is the surface diffusion constant, Γ is the area density of lattice sites, Ω is the volume per atom, γ is the surface energy density and $\Delta\omega$ is the change of the strain energy on the nanowire surface caused by sinusoidal perturbation. $\Delta\omega$ is a function of shear modulus G, Possion ratio ν, surface free energy γ, surface stress τ and misfit m as defined in Ref. 1. At the fastest growth mode, the wavelength of QD array λ_{fg} as a function of core diameter R can be expressed as follow:

$$\lambda_{fg} = 2\pi\sqrt{\frac{2}{-\frac{\Delta\omega}{\gamma} - \frac{1}{(R+t)^2}}} \quad \text{for mode } n=1 \quad (2)$$

where R and t are core diameter and shell thickness respectively.

Furthermore the temperature dependence of the perturbation amplitude δ from equation (1) is used to extract the activation energy of Ge adatoms diffusion. (1) can be reduced to:

$$\ln\delta \propto \frac{1}{kT}\exp\left(\frac{E_A}{kT}\right) \quad (3)$$

where E_A represents the effective activation energy.

By fitting equation (3) using the experiment result in Fig. 5c, the activation energy of 0.67 eV is obtained.

References

(1) Schmidt, V.; McIntyre, P. C.; Gösele, U. *Phys. Rev. B* 2008, *77*, 235302.

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