# Surface Diffusion and Substrate – Nanowire Adatom Exchange in InAs Nanowire Growth

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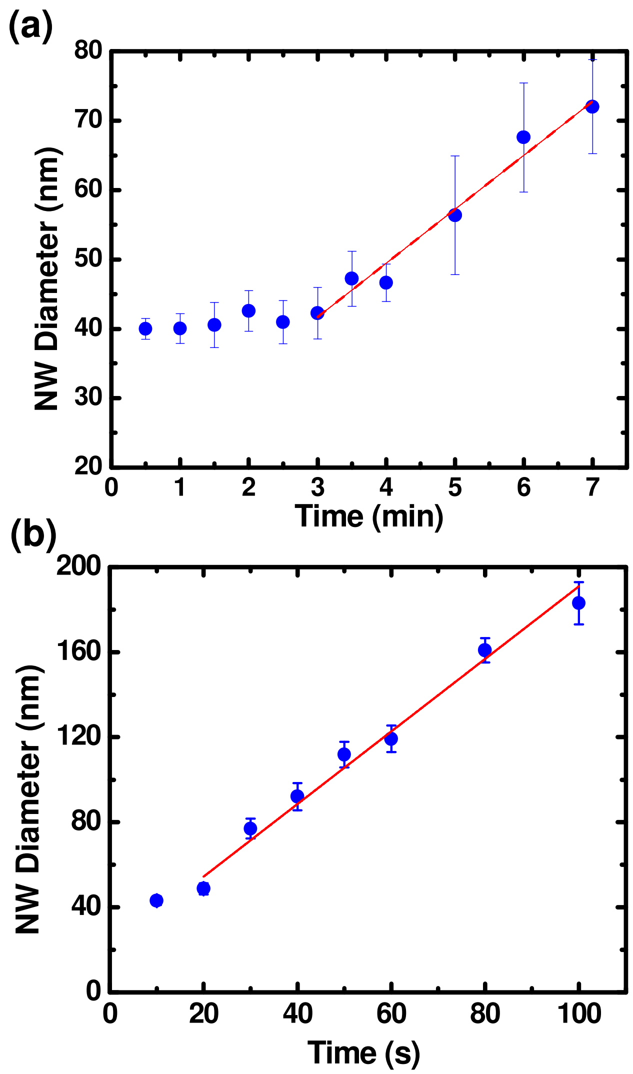


***Figure S1.*** (a) Plot of the NW diameter as function of time for the set of NWs shown in Figure 1 and grown at a TMIn flow of 1 µmol/min. (b) Plot of the NW diameter as function of time for the set of NWs shown in Figure 2 and grown at a TMIn flow of 6 µmol/min.

**Nanowire Elongation Rate:**

As depicted in Figure S2, Ruth and Hirth considered a reactant adatom gradient across the NW sidewalls and growth substrate itself and accounted for different diffusion lengths on both surfaces. After solving the continuity equation on the substrate surface to determine the boundary condition at the NW base and using a moving frame of reference at the NW tip, they were able to solve the continuity equation at the NW sidewalls and obtain a NW elongation rate of

$$\frac{dl}{dt}=\frac{V_L\left\{\sinh\left[l\left(\frac{\omega}{D}\right)^{1/2}\right]+\beta\cosh\left[l\left(\frac{\omega}{D}\right)^{1/2}\right]\right\}}{\left\{\cosh\left[l\left(\frac{\omega}{D}\right)^{1/2}\right]+\beta\sinh\left[l\left(\frac{\omega}{D}\right)^{1/2}\right]\right\}}+I\,, \qquad \text{(SE1)}$$

with $V_L = 2\lambda_{NW}\Omega\left(J - N_0\omega\right)/R$ and $\beta = \frac{\lambda_{sub}}{\lambda_{NW}}\left[\frac{K_1\left(\sqrt{2}r/\lambda_{sub}\right)}{K_0\left(\sqrt{2}r/\lambda_{sub}\right)}\right]$. $l$ is the NW length, $\Omega$ is the In the atomic volume, $J$ is the impingement flux on the NW sidewalls and substrate, $N_0$ is the adatom concentration at the NW tip in equilibrium with the vapor phase– which includes Gibbs Thomson effect –, $\omega$ and $D$ are the adatom desorption frequency and diffusion coefficients, respectively, such that $\lambda_{NW} = \sqrt{\frac{2D}{\omega}}$, $I$ is the impingement current on the NW tip, $K_0$ and $K_1$ are the modified Bessel functions of the 2nd kind of 0th and 1st order, respectively. The term $\beta$ identifies the direction and strength of adatom exchange between the substrate and the NW. This exchange is governed by the relative difference between surface diffusion lengths on the NW sidewalls, $\lambda_{NW}$, and that on the growth surface, $\lambda_{sub}$.

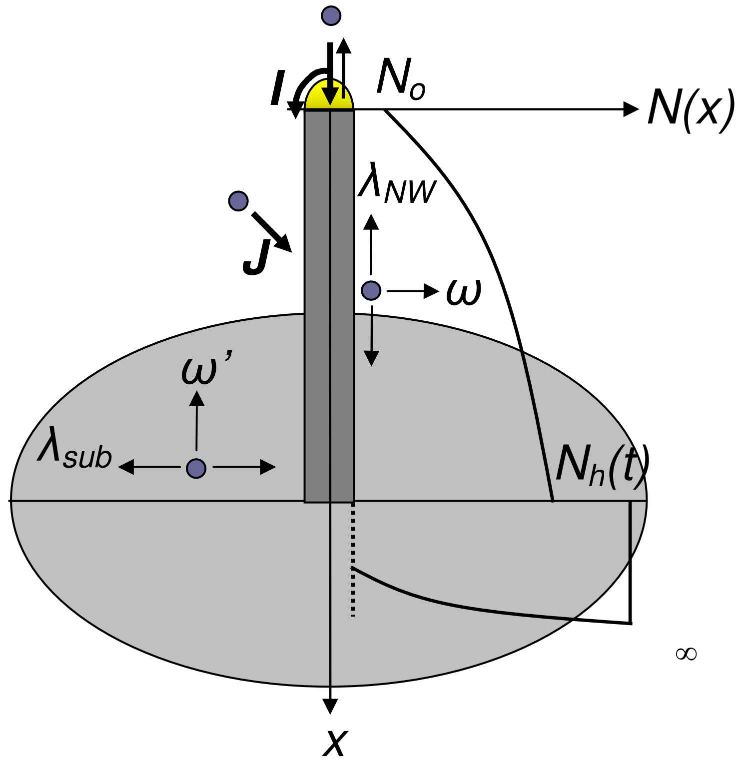


***Figure S2.*** Schematic diagram showing adatom impingement and concentration profiles on the NW sidewalls and substrate surface.

The integral of equation (1) can be expressed as:

$$t = \frac{V_L \lambda_{NW}}{\sqrt{2}\left(V_L^2 - I^2\right)} \ln\left( \frac{\left(\beta + \frac{I}{V_L}\right)\cosh\left[\frac{\sqrt{2}l}{\lambda_{NW}}\right] + \left(1 + \frac{\beta}{V_L}\right)\sinh\left[\sqrt{2}\frac{l}{\lambda_{NW}}\right]}{\left(\beta + \frac{I}{V_L}\right)} \right) - \frac{I}{V_L^2 - I^2} l . \quad \text{(SE2)}$$

Equation SE2 was used in the fittings for the experimental data in Figure 3.