Enhanced absorption in GaAs nanowire arrays grown on silicon substrates

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We report here on equivalent transmittance measurements in GaAs nanowires (NWs) grown on n+ Si(111) substrates, an example of which is shown in the SEM image of Figure 1. The GaAs NWs are grown by molecular beam epitaxy via the Ga-assisted Vapor-Liquid-Solid mechanism. The structural properties of the samples are controlled by varying various growth parameters such as the As-Ga stoichiometry, the substrate anneal time and temperature and Ga pre-deposition time. In order to control the NW diameter we follow a two-stage growth via Ga droplet removal.

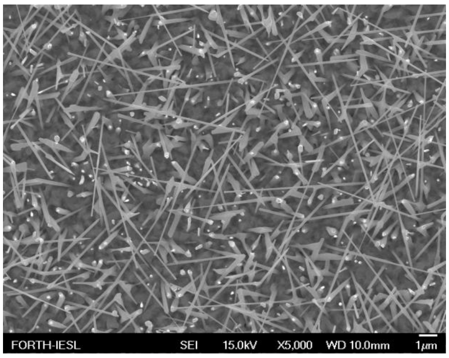

Figure 1: Top view SEM image of a NW Sample.

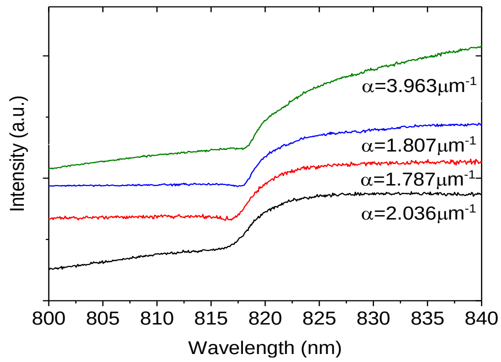

Figure 2: Transmittance spectra at T=20K.

Utilizing a common reflectivity setup, we deduce the transmittance spectra of several NW samples, as the ones shown in Figure 2, from which we estimate the effective absorption coefficient α, based on a modified expression of Beer-Lambert law, taking into account the non-uniform orientation of the NWs on the substrate surface, and neglecting any anisotropy effects,

$$\ln\frac{I}{I_0} = -2 f_p l a - 2 f_t \frac{d}{\cos(\theta)} a$$

where I_0 is the power of the incident light, I the power of the reflected light, f_p the filling factor of the vertical NWs, f_t the filling factor of the tilted NWs, l and d the average height and diameter of the NWs, respectively, and θ the average angle of the tilted NWs with respect to the substrate plane. The α-values in Figure 2 correspond to the low temperature absorption coefficient at the exciton gap for each sample, and clearly indicate pronounced absorption enhancement effects, at least compared to the bulk GaAs where α=1.1μm^{-1}.

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