Electronic Supplementary Material

In Supplementary Material, we summarize the recent reports on experimental and numerical estimations of different surface energies. Table S1 gives the relevant notations and the values of surface energies, which we used in calculations.

Table S1. Notations and values of surface energies.

Surface	Notation	Value, J/m²
GNP - vapor	γ_{GV}	0.05
NW sidewall - GNP	γ_{nG}	0.23
GNP – liquid gallium	γ_{GGa}	0.04
GNP – gold-gallium catalyst	γ_{GAuGa}	0.1
NW sidewall – liquid gallium	γ_{nGa}	0.12
NW sidewall – gold-gallium catalyst	γ_{nAuGa}	0.15
NW sidewall – SiO_x/Si	γ_{nO}	0.6
SiO_x/Si - liquid gallium	γ_{OGa}	0.2
SiO_x/Si - gold-gallium catalyst	γ_{OAuGa}	0.4
NW sidewall – NW sidewall (matched)	γ_{nNW}	0.2
NW sidewall – NW sidewall (mismatched)	γ_{nNW}'	1

Different authors provided different values of graphite/graphene – vapor surface energy γ_{GV}: 0.047-0.055 J/m² in ref. [1], 0.029 J/m² in ref [2], 0.123-0.179 J/m² in ref. [3], 0.06 J/m² in ref. [4]. In our estimations, we used the intermediate value of γ_{GV}=0.05 J/m². In general, the graphite – vapor interface energy is extremely small in comparison with typical values of semiconductor-vapor interface energy ≈ 1 J/m² [5] or liquid – vapor interface energy, which is greater than 0.5 J/m² [2].

The nucleus-graphite surface energy was estimated to 0.23 J/m² [6] for the adsorption sites with the lowest energy.

The relevant GNP-liquid surface energies were estimated with the use of Young's equation:

$$\gamma_{GV} - \gamma_{GL} = \gamma_{LV} \cos\vartheta \qquad \text{(S1)}$$

The index *L* = "Ga" and "*AuGa*" corresponds to pure Ga and Au-Ga droplets respectively.

Here γ_{LV} is the well-known liquid vapor energy equal to $\gamma_{GaV} = 0.7$ J/m² for pure gallium droplet and equal to $\gamma_{AuGaV} = 1$ J/m² for gold-gallium one, pure gold droplet has surface energy 1.15 J/m² [4,7]. ϑ is the contact angle of the droplet on the flat GNP surface shown in Figure S1. We observed the contact angle of gallium droplets to be about 90^0 (Figure S1a) and, therefore, estimated the GNP-gallium interface energy to $\gamma_{GGa} \approx 0.04$ J/m². Gold-gallium droplets demonstrate the contact angle about 100^0 (Figure S1b), from which we deduced $\gamma_{GAuGa} \approx 0.1$ J/m². Droplet compositions were verified by EDX measurements.

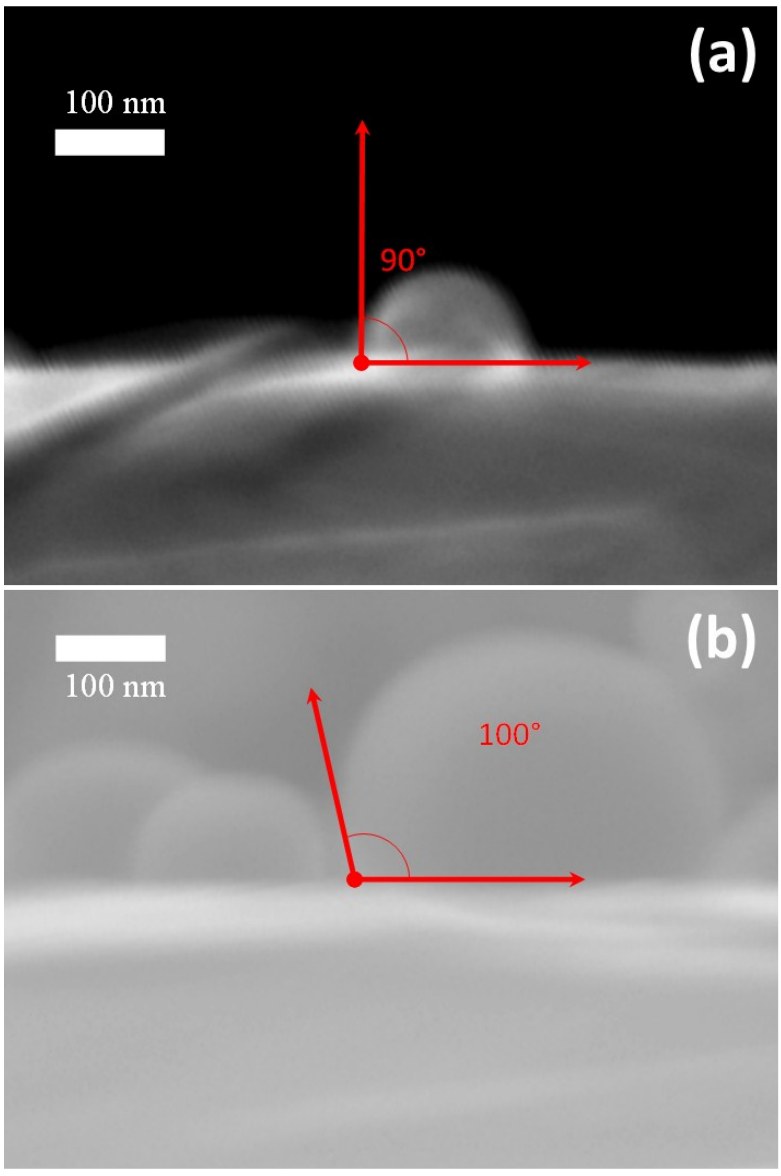

Figure S1. SEM images of catalyst droplets on GNP: (a) Ga droplet, (b) Au-Ga droplet.

The liquid-solid surface energies of NW sidewalls with GaAs(110) facet were estimated previously around $\gamma_{nGa} = 0.12$ J/m² and $\gamma_{nAuGa} = 0.15$ J/m² by Glas et al. in [8].

The energy of the interface between SiO_2/Si substrate and NW sidewall was estimated as the energy of interface with Si assuming that the catalyst etches the oxide layer. So we used the value of surface energy γ_{nO}=0.6 J/m² [9].

Oxide-liquid surface energies were adopted from work: γ_{OGa}=0.2 J/m² [10] and γ_{OAuGa}=0.4 J/m² [11].

The energy of the interface between two NWs could be estimated as interfacial energy of grain boundary, which depends on the orientation angle [12]. Hence we considered two types of interfaces: the matched NW interface with the energy of the faulty stacked sidewalls 0.2 J/m² [13], and the mismatched NW interface with the energy corresponding to GaAs-vacuum surface, which has energy about 1 J/m² [13].

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