Guided growth of horizontal nanowires: A new path to self-integrated nanosystems

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The large-scale assembly of nanowires with controlled orientation on surfaces remains one of the most critical challenges toward their integration into practical devices. We report the vapor-liquid-solid growth of perfectly aligned, millimeter-long, horizontal GaN [1] and ZnO [2] nanowires with controlled crystallographic orientations on different planes of sapphire and other substrates. The growth directions, crystallographic orientation and faceting of the nanowires vary with each surface orientation, as determined by their epitaxial relationship with the substrate, as well as by a graphoepitaxial effect that guides their growth along surface steps and grooves. Despite their interaction with the surface, these horizontally grown nanowires display few structural defects, exhibiting optical and electronic properties comparable to those of vertically grown nanowires. Guided GaN nanowires and ZnO nanowires present general similarities and a few interesting differences, which shed light into the guided growth mechanism. The controlled horizontal growth of nanowires of different materials on different substrates proves the generality of the guided growth approach. Recently, we demonstrated the feasibility of massively parallel "self-integration" of NWs into electronic circuits and functional systems based on guided growth [3].

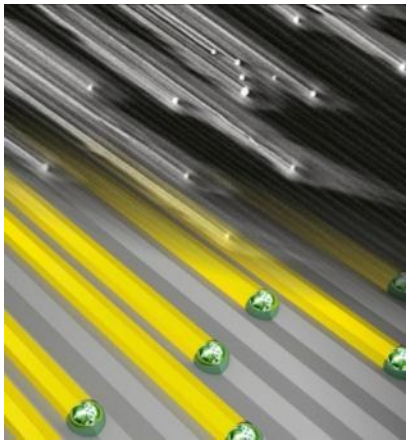

Figure 1. Guided nanowires on the nanogrooves of a spontaneously faceted surface.

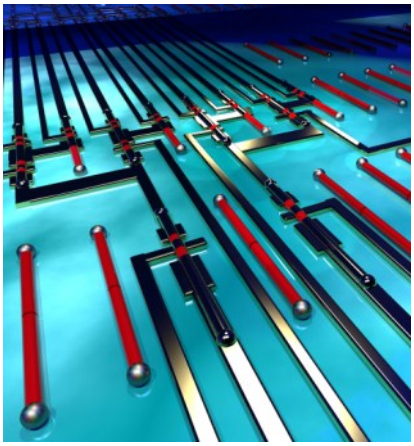

Figure 2. Self-integration of nanowire into circuits via guided growth

[1] D. Tsivion, M. Schvartzman, R. Popovitz-Biro, P. von Huth, E. Joselevich, *Science*, **333**, 1003 (2011).
[2] D. Tsivion, M. Schvartzman, R. Popovitz-Biro, E. Joselevich, *ACS Nano*, **6**, 6433 (2012).
[3] M. Schvartzman, D. Tsivion, D. Mahalu, O. Raslin, E. Joselevich. *Proc. Nat. Acad. Sci. USA* (2013), DOI:10.1073/pnas.1306426110.