Supporting Information

In-Plane Nanowires with Arbitrary Shapes on Amorphous Substrates by Artificial Epitaxy

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Nanowires growth scheme

The growth of nanowires from different materials is carried out in a three-zone horizontal-tube furnace. The relevant precursor is held in the first heating zone of the furnace, while the patterned silicon sample is placed downstream in the second heating zone and held at the appropriate temperature. Pressure, gas content and flow, as well as temperatures are chosen according to the growth conditions formerly found for each material on sapphire. \(^1\)\(^-\)\(^5\) After the growth period, the furnace is moved away so the sample can rapidly cool down to room temperature.

Figure S1. Growth system illustration: A quartz tube placed in a 3 zone furnace. The samples are placed downstream from the precursor.
Fabrication of trenches by Nanoimprint lithography (NIL) followed by wet-etch

The following scheme describes the fabrication of smooth isotropic trenches by NIL followed by wet etch of the SiO$_2$ layer.

Figure S2: Schematics of open trenches fabrication by NIL and wet-etch: (a) PMMA imprint resist is spin coated on a Si/SiO$_2$ (300nm) wafer. b) The master mold is pressed into the PMMA. c) The sample after separation from the mold. d) The residual PMMA is etched by a gentle reactive ion etching. e) The SiO$_2$ layer is etched by BOE f) Liftoff of remaining resist

Fabrication of ridges by NIL followed by alumina evaporation

The following scheme describes the fabrication of sharp (90° profile) ridges by NIL followed by evaporation of amorphous alumina on top of the SiO$_2$ layer.
**Figure S3: Schematics of open ridge fabrication by NIL and alumina evaporation:**

a) PMMA imprint resist is spin coated on a Si/SiO$_2$ (300nm) wafer. b) The master mold is pressed into the PMMA. c) The sample after separation from the mold. d) Angle evaporation of Ti. e) the residual PMMA is etched by a gentle reactive ion etching. f) electron-beam evaporation of alumina g) Liftoff of remaining resist

**ZnSe nanowires in a ridge configuration: Morphology, crystal quality and crystallographic orientation analysis**

TEM cross-section images of additional guided ZnSe nanowires in a ridge configuration. The nanowires are not confined inside the trenches. The alumina wall (only 10 nm in height) only guides the direction of the growth. The principle part of the nanowire grows on top of the oxide layer and is free to expose its facets. No plane defects are observed. Using FFT, a preferred crystallographic orientation is found to be [1̅213].
Figure S4: Additional examples of cross-sectional TEM images of guided ZnSe nanowires in a ridge configuration. A) Nanowires morphology: The nanowires are guided by the 10 nm alumina wall, where the principle part of the nanowire grows on top of the oxide layer. Faceting is clearly observed. B) Crystal quality: Higher magnification shows single crystals with no plane defects. C) Crystallographic orientation analysis: Table of crystallographic orientation analysis. Five out of seven wires were found to grow along the $[1\bar{2}13]$ direction.
**Longitudinal lamella of a ZnSe nanowire in a ridge configuration**

To further examine the morphology and crystallinity, we cut a longitudinal lamella along a ZnSe nanowire grown along a lithographic ridge (Figure S5). The structure and diameter are uniform along a few microns. Higher resolution images display atomic fringes in the ZnSe crystal, and FFT analysis in different locations present a similar diffraction pattern, indicating a single crystal.

![ZnSe nanowire TEM images](image.png)

**Figure S5: A longitudinal TEM images of a ZnSe nanowire in a ridge configuration.**
(a) A low-magnification TEM image (b) A medium-magnification TEM image and (c) high-magnification image presenting crystal fringes. FFT analysis from different regions present the same diffraction pattern and indicating a single crystal.
GaN nanowires in a trench configuration: Morphology, plane defects and crystallographic orientation analysis

TEM cross-section images of additional guided GaN nanowires in a trench configuration. The silica layer wraps the bottom part of the nanowire that therefore appears rounded at the interface. The upper, exposed part shows clear facets. Although the nanowires examined are single crystals, plane defects are observed. Using FFT, a preferred crystallographic orientation is found to be $[\bar{1}210]$. $[1\bar{1}00]$ is also common.

| Number of nanowires | Crystallographic orientation |
|----------------------|------------------------------|
| 7                    | $[\bar{1}210]$              |
| 4                    | $[1\bar{1}00]$              |
| 1                    | $[1\bar{1}01]$              |
| 1                    | $[1\bar{2}13]$              |
Figure S6: Additional examples of cross-sectional TEM images of guided GaN nanowires in a trench configuration. A) Nanowires morphology: The nanowires are guided inside the silica trench, which envelops the bottom part of the nanowire. The lower part, which is in contact with the interface, is rounded and in the upper, exposed part, faceting is clearly observed. B) Crystal quality: Higher magnification shows single crystals with significant plane defects. C) Crystallographic orientation analysis: Table of crystallographic orientation analysis. Seven out of thirteen wires were found to grow along the [1210] direction. Four were found to grow along the [1\overline{1}00] direction.

Catalyst dewetting and growth of nanowires

Microscale islands of metallic catalyst are patterned perpendicular to the lithographic guides by a standard photolithography process, followed by electron-beam evaporation of a thin film (nominal thickness 0.5 nm) of the catalyst metal. After heating the sample at 550°C, the metallic film breaks into nanodroplets in a dewetting process. These droplets are used as the catalyst in the VLS mechanism. As can be seen in figure S7, the density of metallic droplets is quite high, comparable to the density of lithographic guides. However, the yield of GaN nanowires is lower. From this observation we conclude that the yield of nanowires growth is limited by the synthesis conditions and not by the catalyst density.
Figure S7: SEM image of straight GaN Nanowires growing in nano-lithographic guides made by EBL in a ridge configuration. Micro-scale stripe of Ni metal is broken to nanodroplets upon dewetting. GaN nanowires grow from catalyst droplets in a VLS mechanism.
Guided ZnO by artificial epitaxy

Figure S8: ZnO growth on lithographic open trenches: a) SEM top view of ZnO after CVD. Trenches are fabricated by NIL followed by wet etch. b) Cross-sectional TEM of the same sample. Lamella was made by FIB c) Zoom in on a single structure. ZnO in observed as a thin layer on top of the SiO$_2$ peak. Inset: EFTEM taken on additional structure showing Zn in magenta and Si in turquoise. d) ZnO growth in sine wave-shaped trenches. e) Additional ZnO growth in straight trenches.
Figure S9: SEM images of master mold after writing and developing of HSQ resist.

a) Sixty degree zigzag pattern. b) Sine wave c) concentric flowers d) spiral
Cathodoluminescence of sine wave-shaped ZnSe nanowire

CL spectrum reveals that in addition to the NBE peak of ZnSe, defect emission exists at wavelengths larger than 480 nm. This typical spectrum shape is observed throughout the entire structure of sine wave-shaped ZnSe nanowire, with no correlation with the periodic structure. The observation of defect emission is in agreement with the large extent of VS growth clearly seen in SEM imaging.

Figure S10: CL spectrum of sine wave-shaped ZnSe nanowire. Defect emission is observed at 486 nm, in addition to the NBE peak at 463 nm.
Photoluminescence of sine wave-shaped GaN nanowire

Full spectrum of a sine wave-shaped GaN nanowire. No significant yellow luminescence, which is correlated with defects in GaN, is observed either in straight or in curved regions. This can be best seen in the intensity map at the range of 500-650 nm (S11c).

**Figure S11:** (a) PL spectrum of a single sine wave-shaped GaN nanowire. (b) Overlay of SEM image of sine wave-shaped GaN nanowire and PL intensity map of the NBE (between 300-400 nm). (c) Overlay of SEM image of sine wave-shaped GaN nanowire and PL intensity map of the yellow tail (between 500-650 nm).
Nanoimprint machine

Figure S12: Homebuilt nanoimprint lithography machine
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