

## Supporting Information

Where is the required lattice match in horizontal growth of nanowires?

*Babak Nikoobakht\*and Andrew Herzing*

Material Measurement Science Division,  
National Institute of Standards and Technology,  
Gaithersburg, 20899, MD, USA

Corresponding Author: Babak Nikoobakht,

Material Measurement Science Division,

100 Bureau Dr Stop 8372, Gaithersburg, MD 20899,

Tel: 301-760-8167, Fax: 301-926-6689,

Email: [babakn@nist.gov](mailto:babakn@nist.gov)

## 1-Figure Captions:

Figure S1: a) HRTEM image of the NW lattice at the vicinity of the gold catalyst. Inset shows the FFT pattern of the lattice which is in agreement with the bulk diffraction pattern of TiO<sub>2</sub> anatase with a ZA of [112] shown in part (b). c) Moving toward the base of the NW, HRTEM imaging shows that the NW lattice maintains its bulk lattice dimensions to about 50 nm above the interface. d) A closer view of the HRETM image of the interface of TiO<sub>2</sub> and GaN, which contains the base of a standing NW and major part of a horizontal NW. The SAED pattern of this region is also shown.

Figure S2: a) Position of *a*-plane sapphire in its hexagonal crystal structure. b) Tilted view of TiO<sub>2</sub> NWs horizontally grown on *a*-sapphire. Inset: Growth direction of a NW relative to *a*-sapphire. c) TEM image of in-plane section of a group of horizontally grown TiO<sub>2</sub> NWs.

Figure S3: a-b) Laterally grown TiO<sub>2</sub> NW on *a*-sapphire can also grow from side facets via a non-VLS growth process. The resulting 2D particles are enclosed with 4 facets. c) Schematically shows the crystallographic directions of the nanocrystals.

Figure S4: Post growth analyses of the gold catalyst in both horizontal and upright NWs show that gold maintains its face-centered cubic (*fcc*) structure although at 900 °C it forms a eutectic solution with Ti and O species. a) In the case of horizontal NWs: cross-sectional HR-TEM image along the NW length shows that (111) gold plane || (0001) GaN.. b) In the case of upright NWs, HR-TEM shows that gold has a different alignment in which the (002) Gold || (0001) GaN. Inset images show the FFT patterns of the gold and TiO<sub>2</sub> lattices to determine their plane spacing, orientation and their comparison with the bulk crystal data. c) Electron backscatter diffraction and Kikuchi lines of gold confirms the *fcc* structure of the gold.

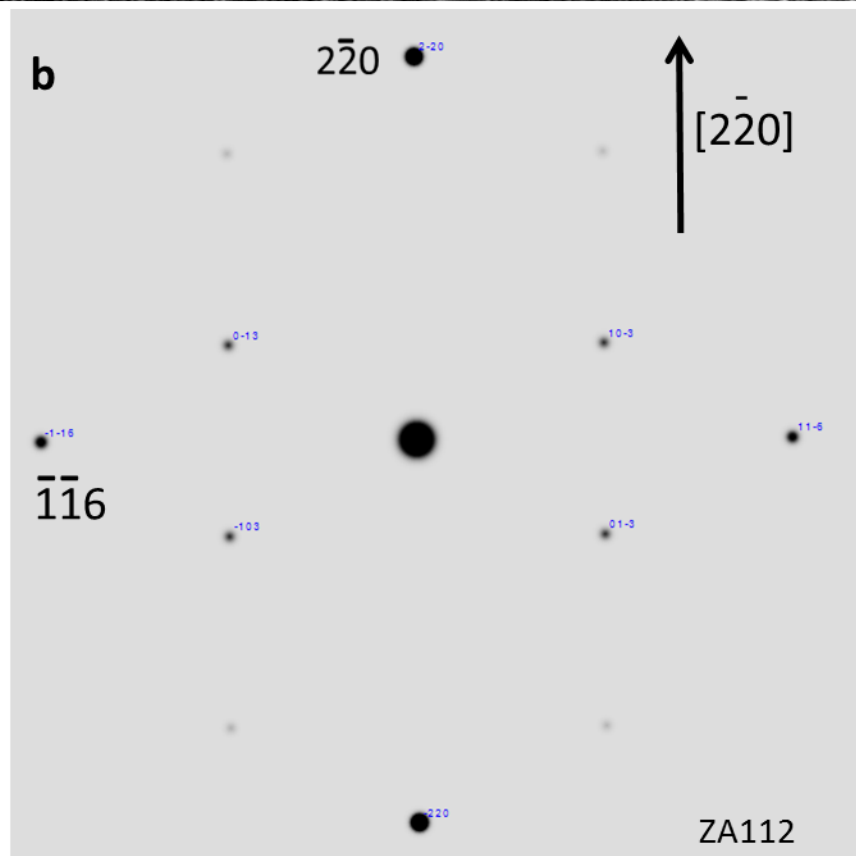
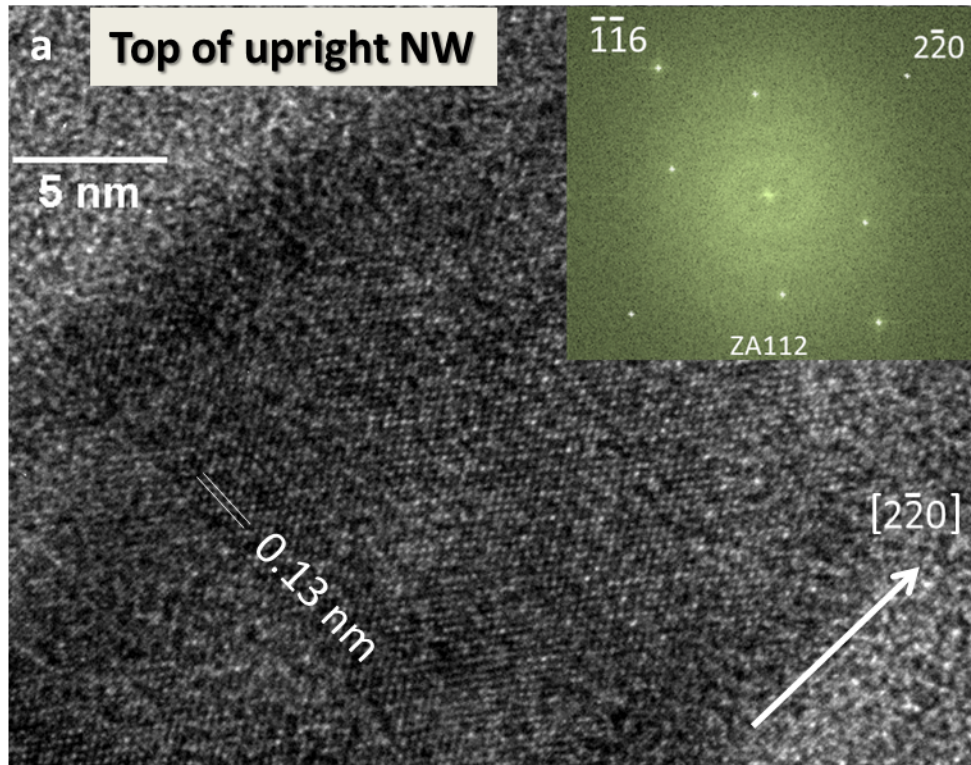


Figure S1-a,b

Area in red circle of Fig.2C

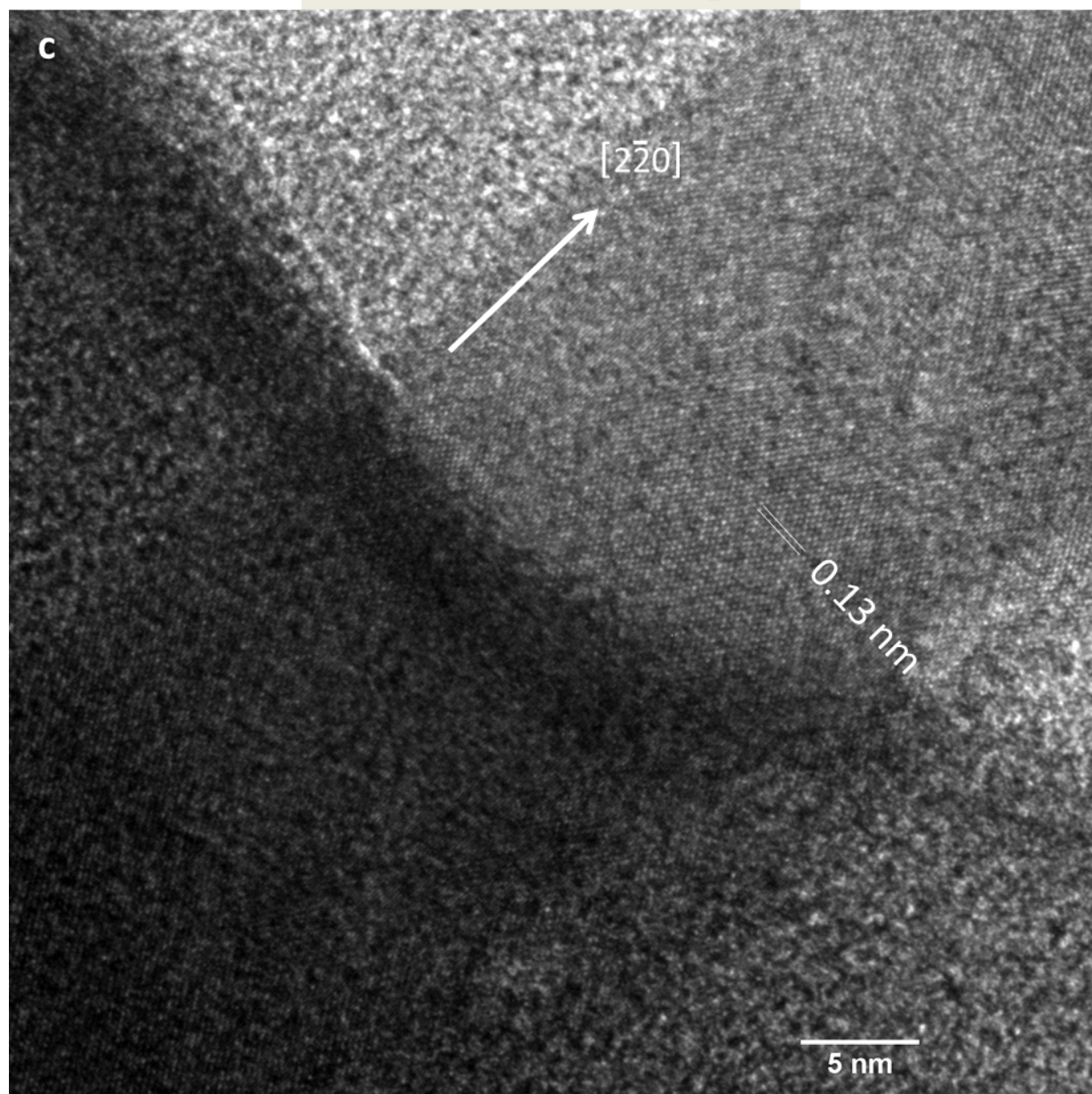


Figure S1-c

TiO<sub>2</sub>/GaN interface including HNW and upright NWs

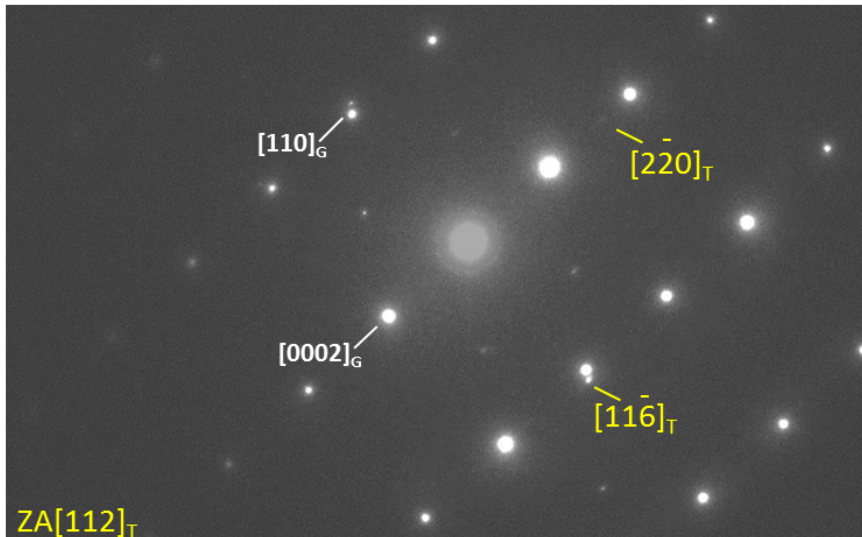
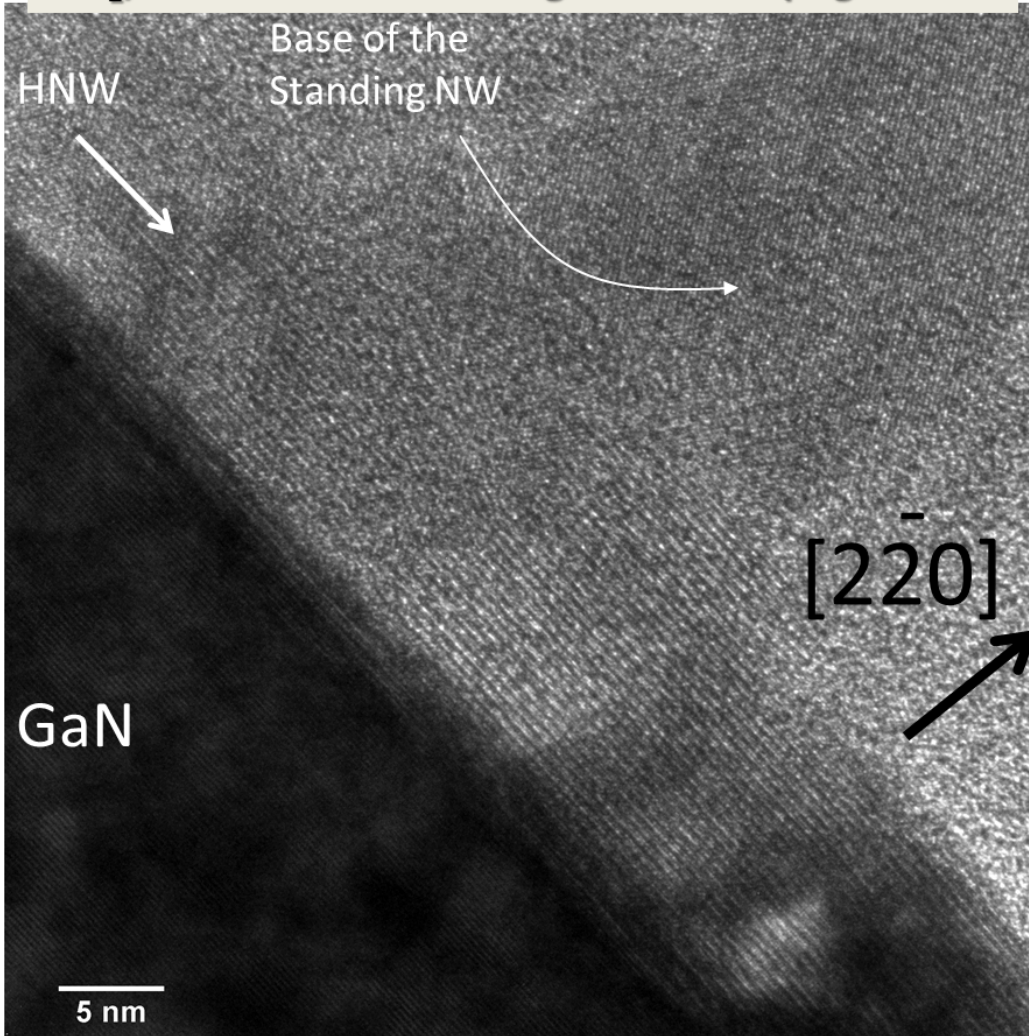


Figure S1d

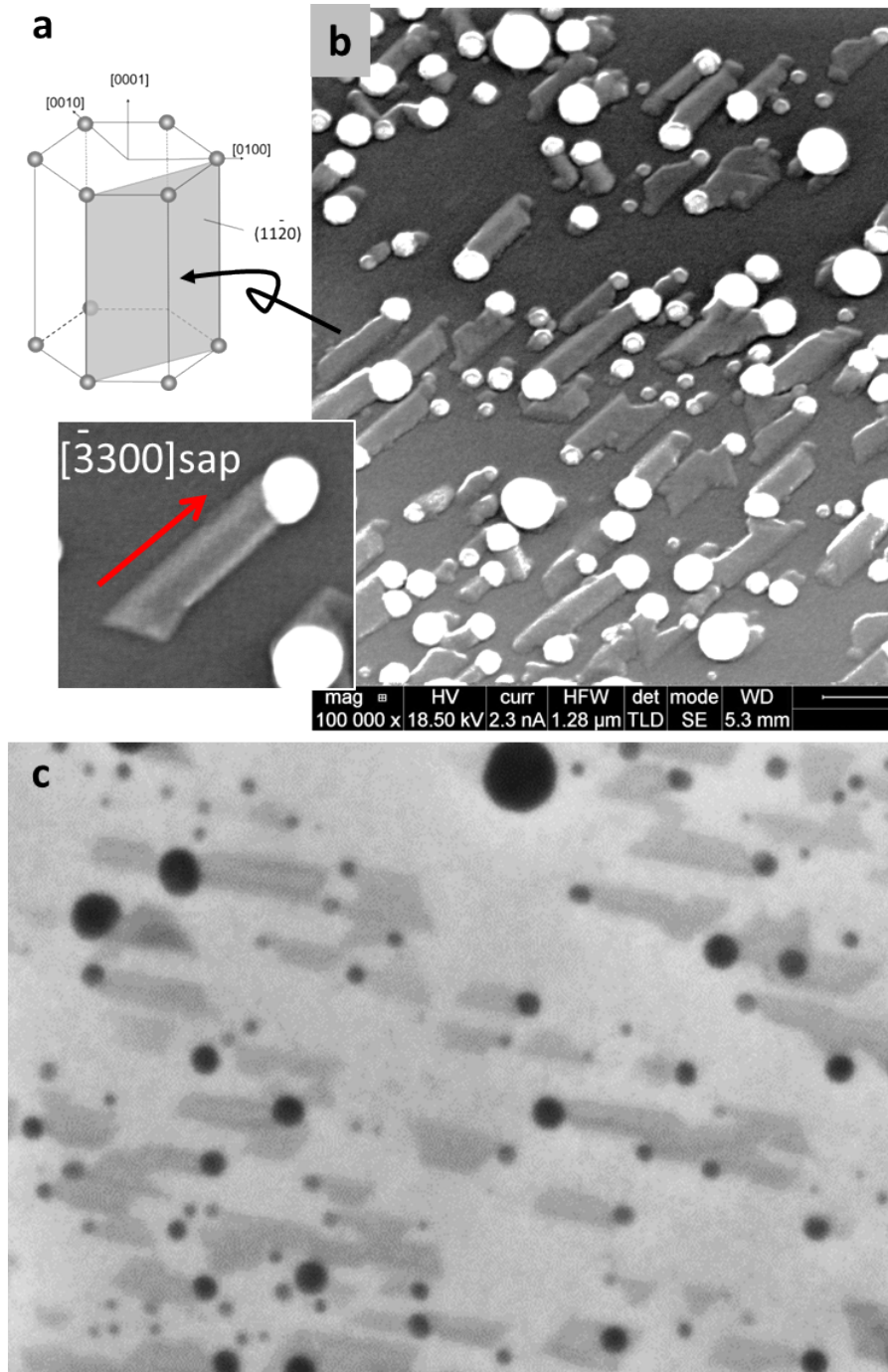


Figure S2

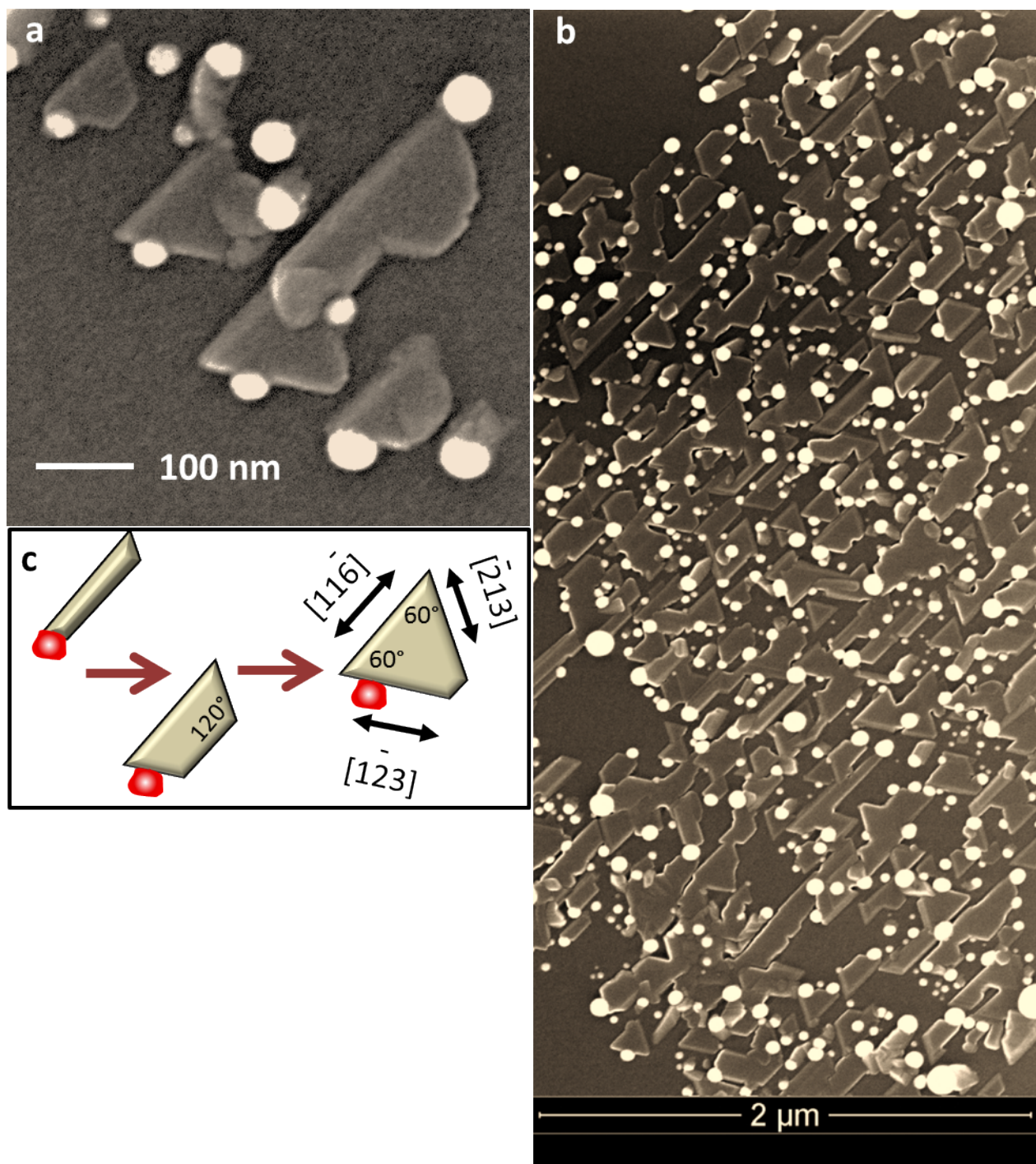


Figure S3

HR-TEM cross section of a horizontal NW along length

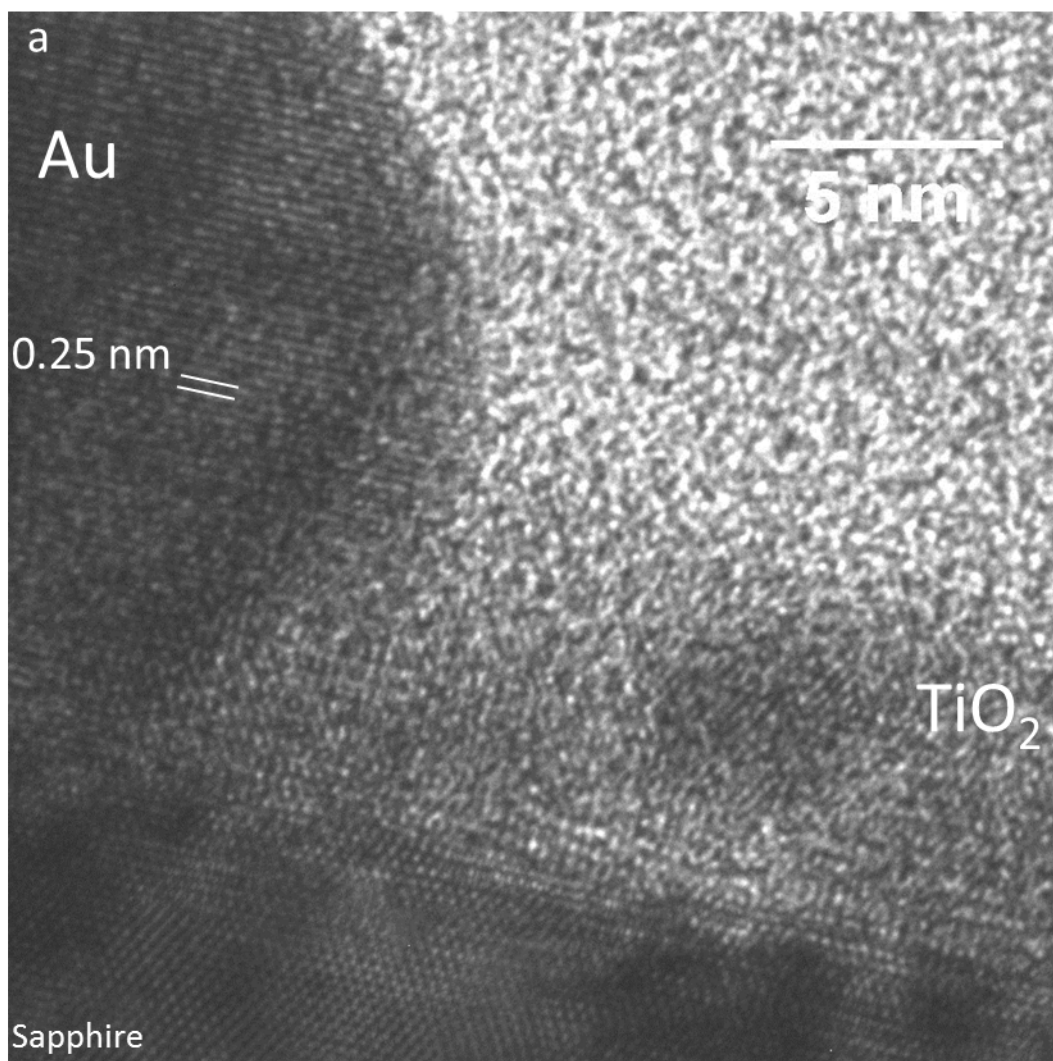


Figure S4a



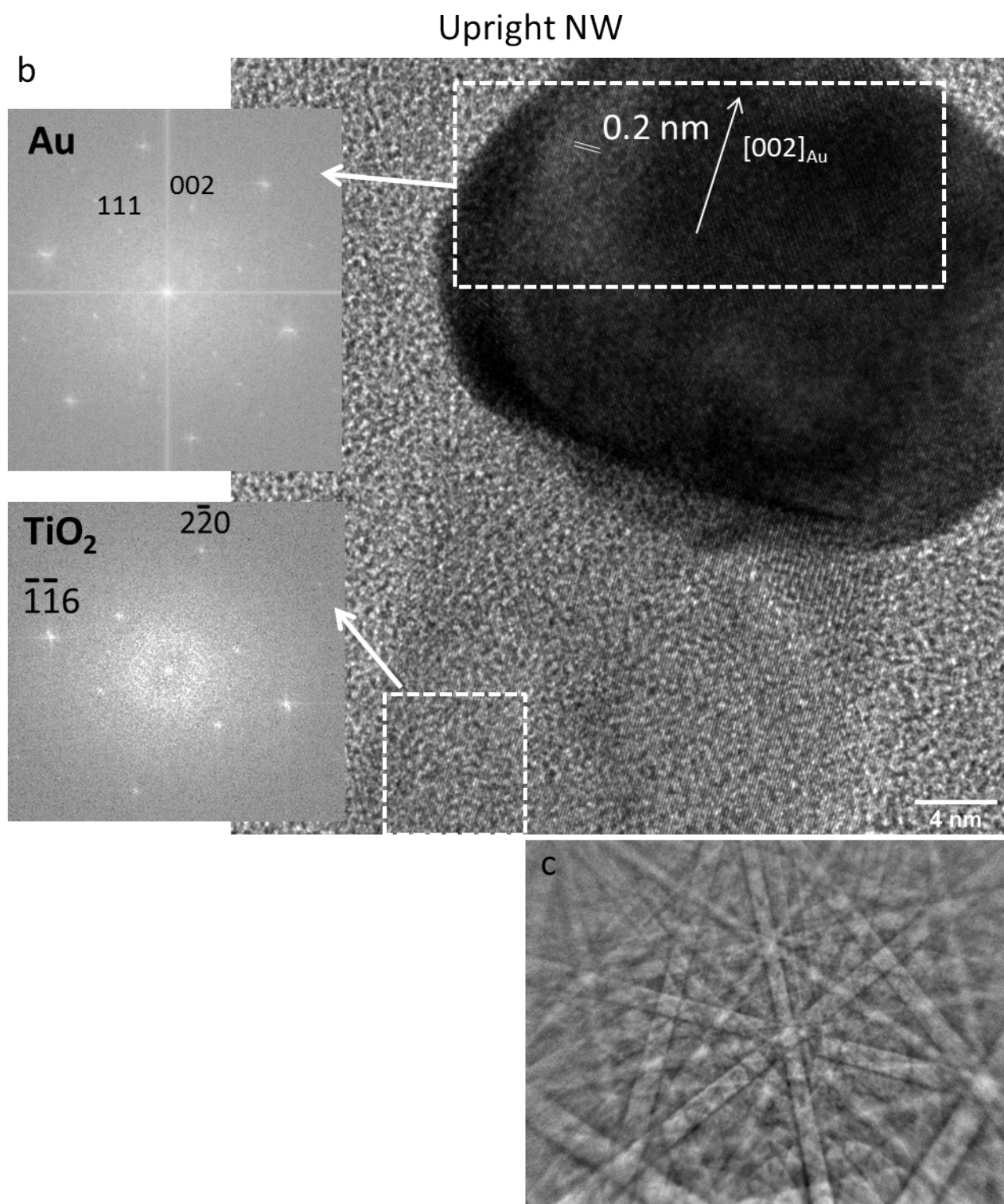


Figure S4(b-c)

### **Indexing the diffraction pattern of NWs:**

In the diffraction patterns of Figures 2d and 4b,  $[112]$  and  $[\bar{1}\bar{1}6]$  are considered orthogonal. These directions are also perpendicular to the  $[\bar{2}\bar{2}0]$  zone axis. For anatase, the unit cell is elongated in its  $c$  direction and thus different from a cubic crystal ( $a=b=c$ ). As such the dot product of the reciprocal lattice vectors of  $[112]$  and  $[\bar{1}\bar{1}6]$  becomes  $(1/a, 1/a, -6/c) \cdot (1/a, 1/a, 2/c)$ . Since  $c \sim 2.5 a$ , the dot product becomes zero. Indexing and simulation of crystal planes and diffraction patterns have been performed using “Crystal Maker” version 1.0.1.