Supporting information for

InAs nanowire arrays for room-temperature ultra-broadband infrared photodetection

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1. Nanowire Synthesis

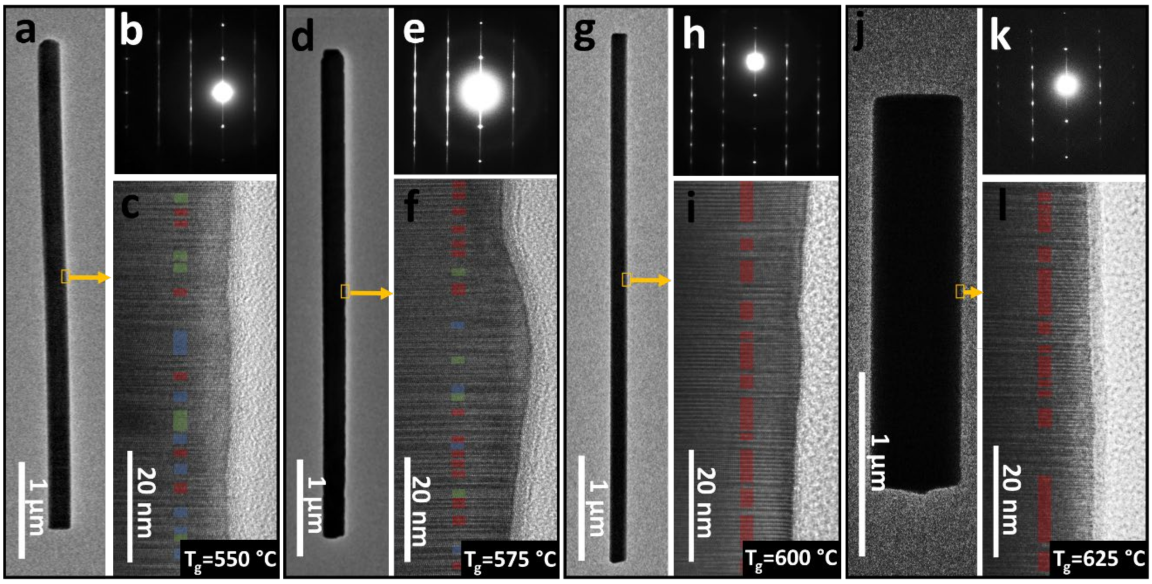

Fig. S1 The effect of growth temperature on the crystal structure of InAs nanowires grown on a mask with a hole size of 150 nm and pitch size of 1 µm at a V/III ratio of 15. (a,d,g,j) TEM images of selected nanowires and (b,e,h,k) their respective diffraction pattern at each growth temperature as indicated. (c,f,i,l) Selected high-resolution TEM images taken from the middle of each nanowire.

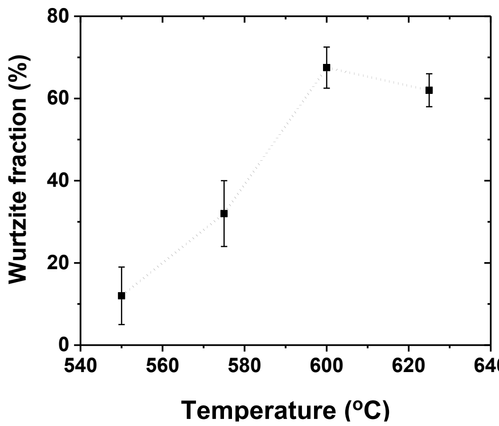

Fig. S2 Percentage of nanowire WZ section as a function of growth temperature at a constant V/III ratio of 15. Error bars represent the standard deviation of four representative nanowires from each array.

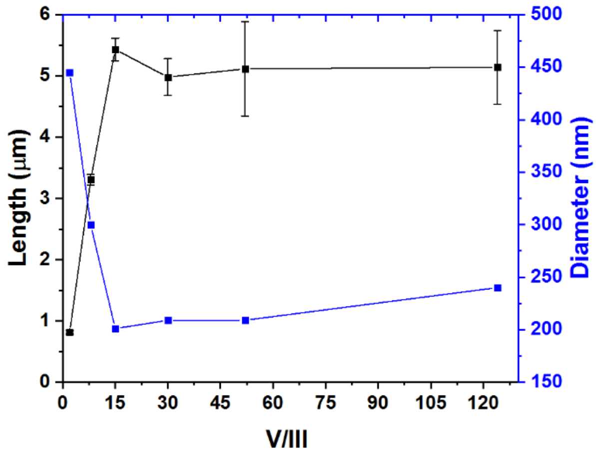

Fig. S3 Variation in length and diameter of InAs nanowires grown at 600 °C with different V/III ratios.

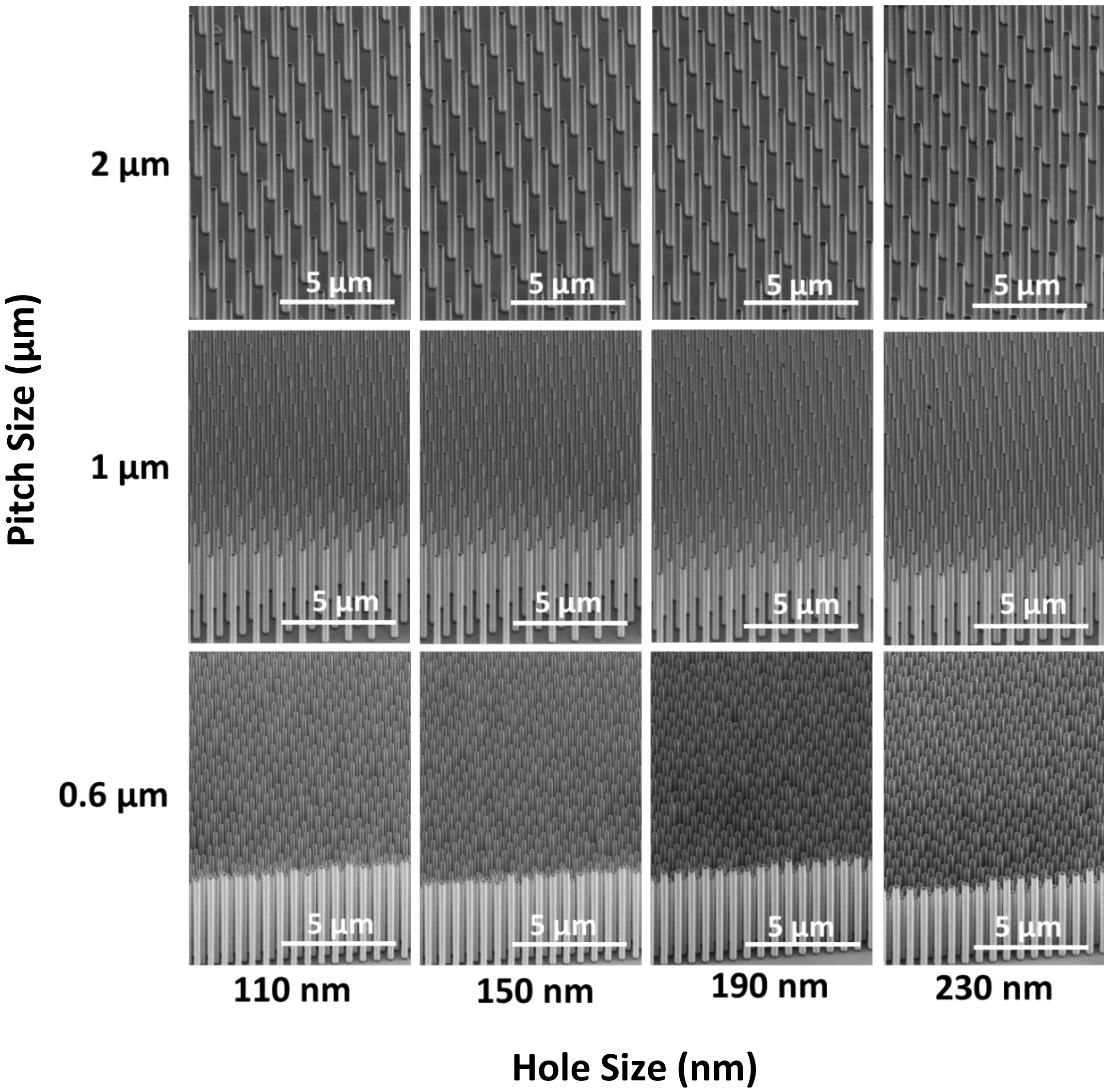

Fig. S4 SEM images of InAs nanowires grown at 600 °C with a V/III ratio of 15 for 8 min with different hole and pitch sizes. Samples are imaged at a 45° tilt.

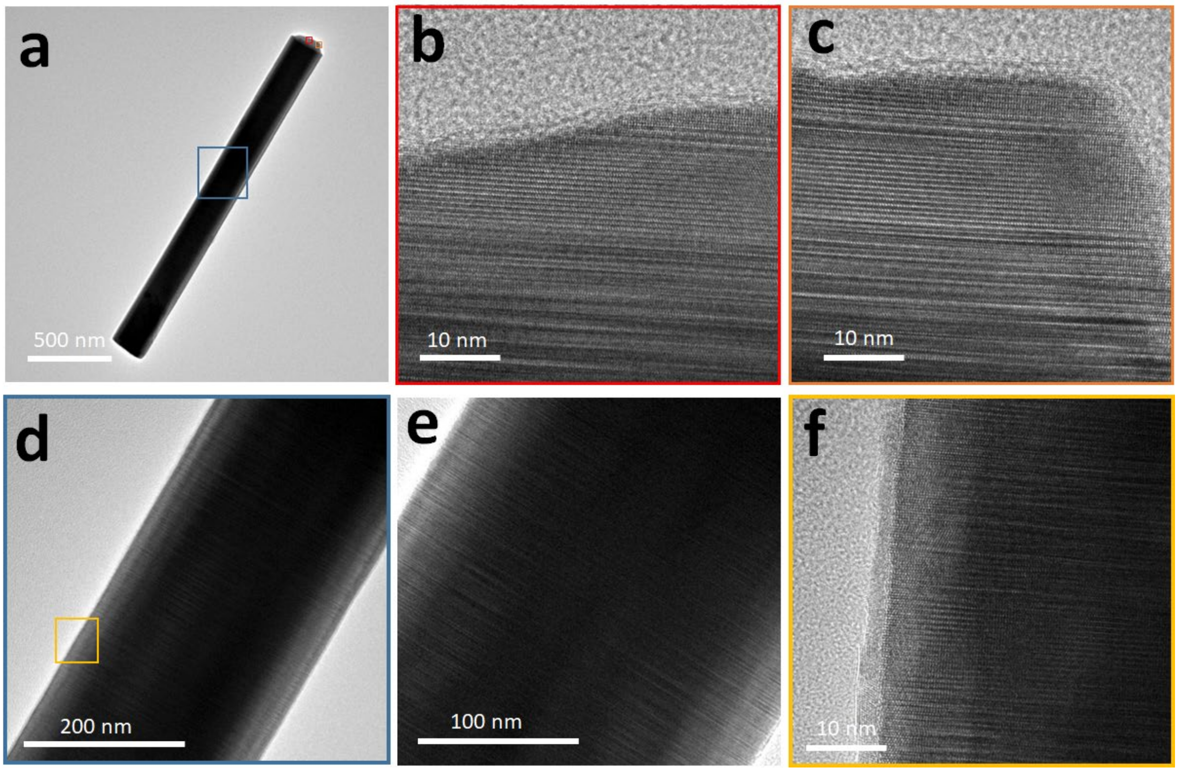

Fig. S5 TEM analysis of the nanowires grown at 600 °C with a V/III ratio of 15 for 210 sec. HR-TEM analysis confirmed the same stacking faults extending radially from the core to nanowires surfaces. (b-d) HR-TEM and TEM images of selected areas with different colours in (a). (f) HR-TEM images of selected areas in (d).

2. COMSOL Electrical Modelling

The electrical simulations were performed with COMSOL Semiconductor Module. The values of material properties are summarised in Table S1. The simulation is built on a 2D domain extracted from the 3D optical simulation in the main text. Both the top and bottom boundaries are set to Ohmic contacts, and the majority of the NW surface is set to surface recombination boundary condition. The surface recombination velocity (SRV) is related to the surface defect density N_{ts} by:

$$SRV = \sigma v_{th} N_{ts}$$

where σ is the surface carrier capture cross-section, and v_{th} is the carrier thermal velocity given by $v_{th} = \sqrt{3k_B T/m^*}$, where m^* is the carrier effective mass.

Table S1. Material and Model Parameters in the Electrical Simulations

Material/Model Parameters	Value	Comments
Electron Mobility	1200 $cm^2 Vs^{-1}$	Ref.[1]
Hole Mobility	250 $cm^2 Vs^{-1}$	Ref.[2]
SRH Recombination Lifetime	660 ps	Ref.[3]
Activation Energy of SRH Recombination Centers	0.05 eV	Obtained from the fitting shown in Figure 3c
Doping Concentration of NW	Adjustable Parameter	
Doping Concentration of p-type InAs substrate	3×10^{18} cm^{-3}	
InAs Electron Effective Mass	$0.023m_0$	m_0 is the free electron mass
InAs Hole Effective Mass	$0.41m_0$	
Carrier Surface Capture Cross-Section	$10^{-10}cm^2$	Ref.[2]
Surface Defect Density	Adjustable Parameter	

3. Nanowire Array Photodetectors

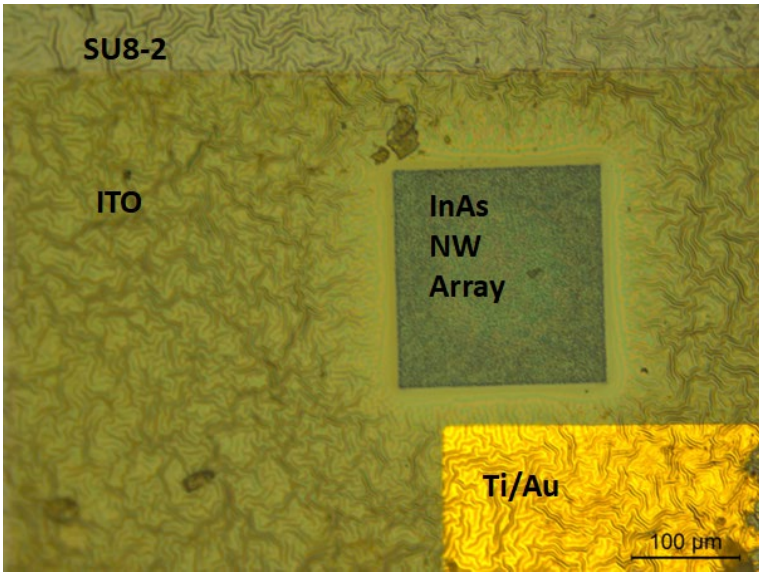

Fig. S6 Optical image of an InAs nanowire array photodetector.

4. COMSOL Optical Modelling

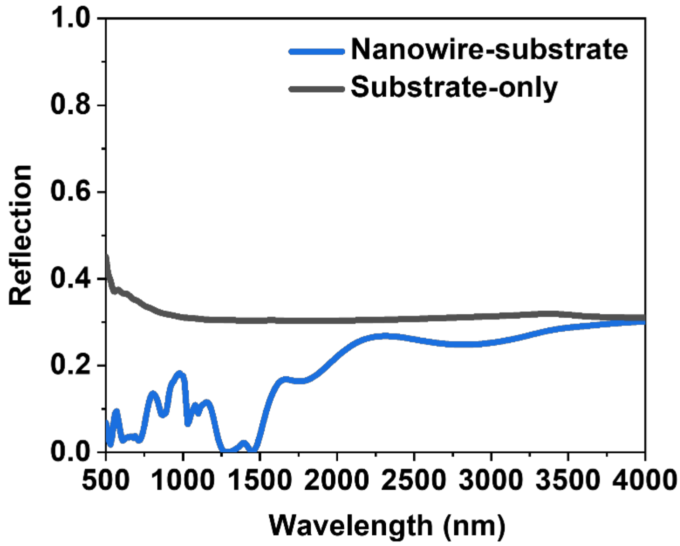

Fig. S7 Simulated reflection spectrum of InAs nanowire-substrate (blue line) and substrate-only (black line) structures.

References

1. J. Seidl, J. G. Gluschke, X. Yuan, S. Naureen, N. Shahid, H. H. Tan, C. Jagadish, A. P. Micolich and P. Caroff, *Nano Lett.*, 2019, **19**, 4666-4677.
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