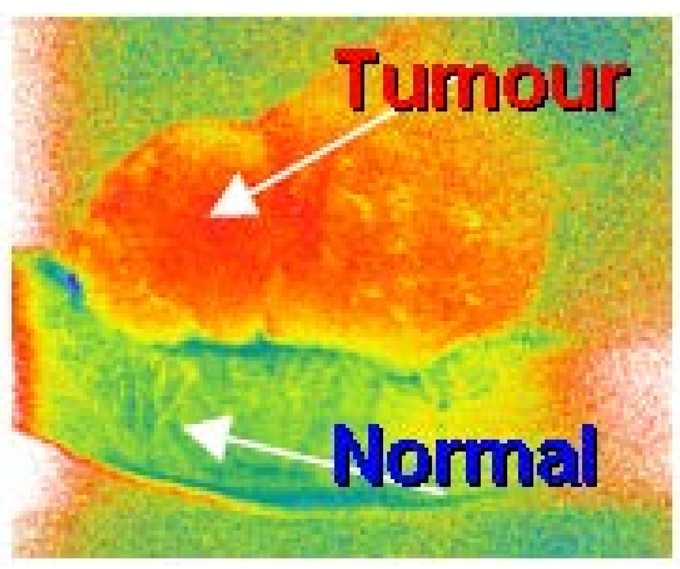
Infrared Detection with Nanowire Photodetectors

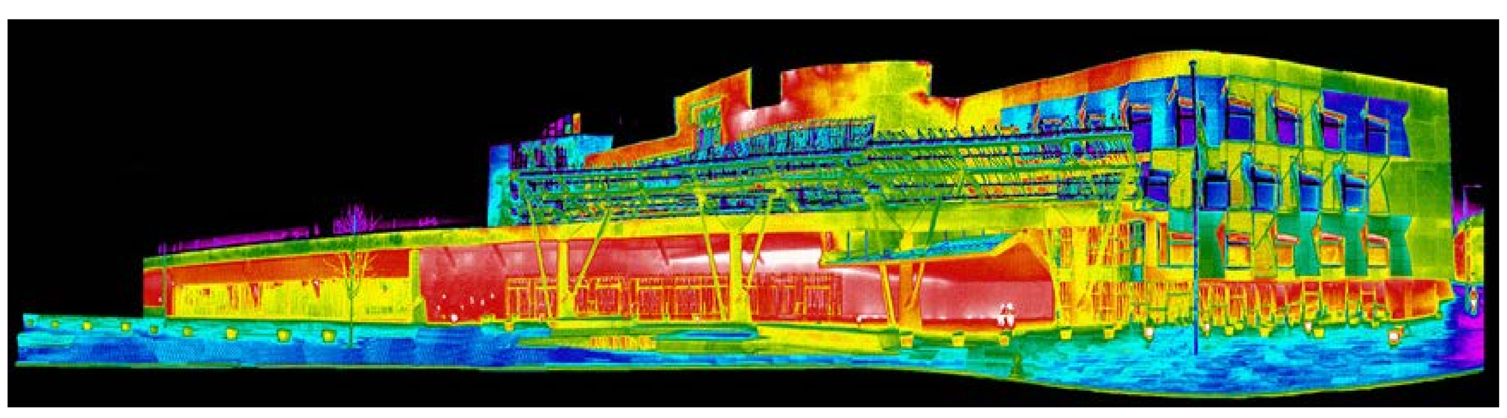
Infrared radiation (IR) covers the spectral range from about 0.75 to 1000 μm. There is a strong commercial interest in novel IR detector designs for IoT applications related to e.g. communication, security, safety, medicin and temperature imaging. Nanowire-based photodetectors have recently emerged as a promising key technology to cover this electromagnetic region.

Background and Motivation

Nanowires (NWs) have attracted considerable attention due to their interesting properties and exciting prospects for applications in nanophotonics e.g. light-emitting diodes (LEDs), lasers, sensors and photodetectors.

In this work, we present the design, fabrication and characterization of NW photodetectors for IR detection.



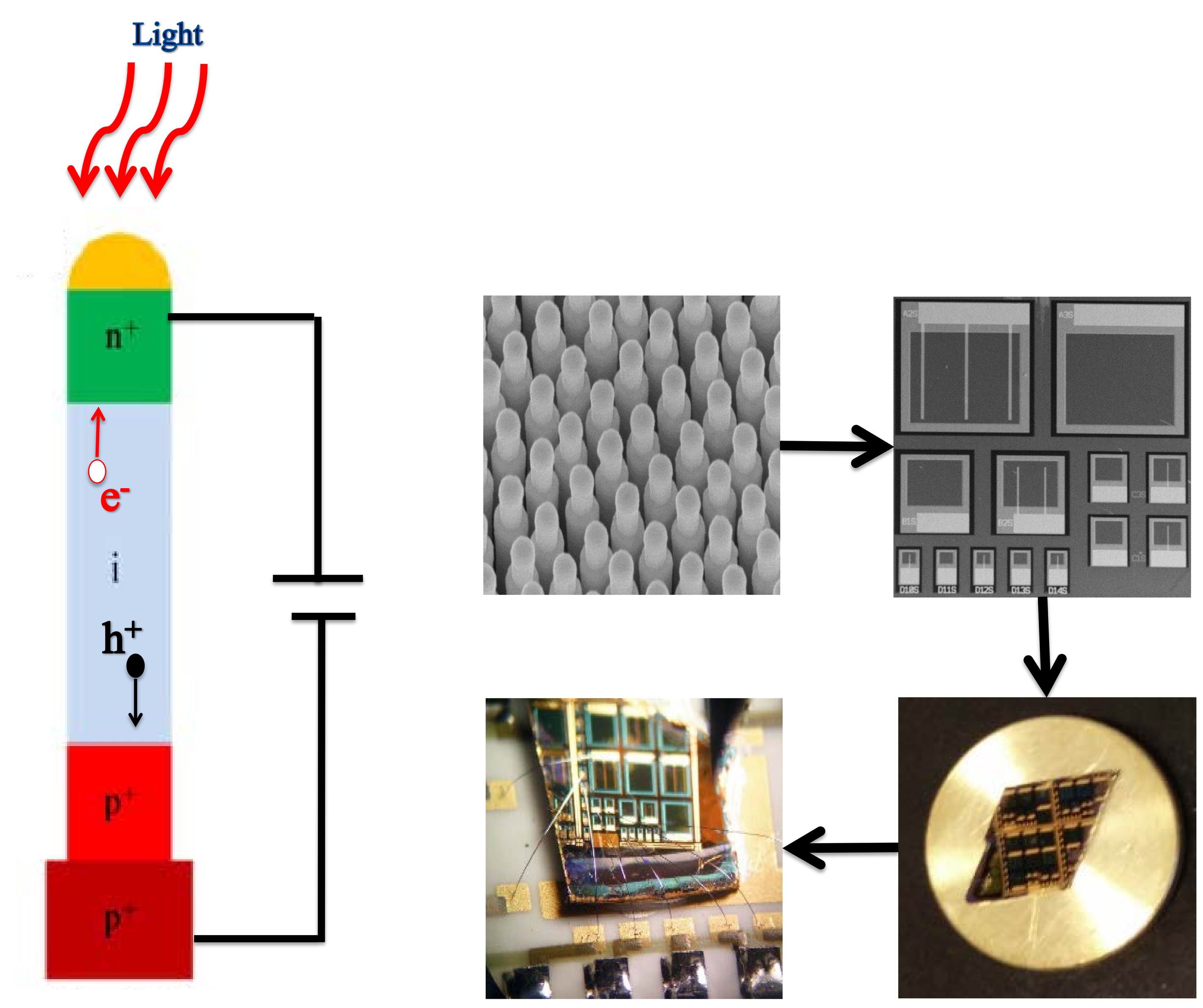


The samples were prepared by first depositing gold catalyst nanoparticles on a p^+ InP substrate using an aerosol technique and subsequently growing NWs using MOVPE. The processing of the detectors include deposition of SiO_2, followed by an etching step to remove the oxide from the tip of the NWs, and finally sputtering of ITO on 1x1 mm^2 device areas (images on right-hand side).

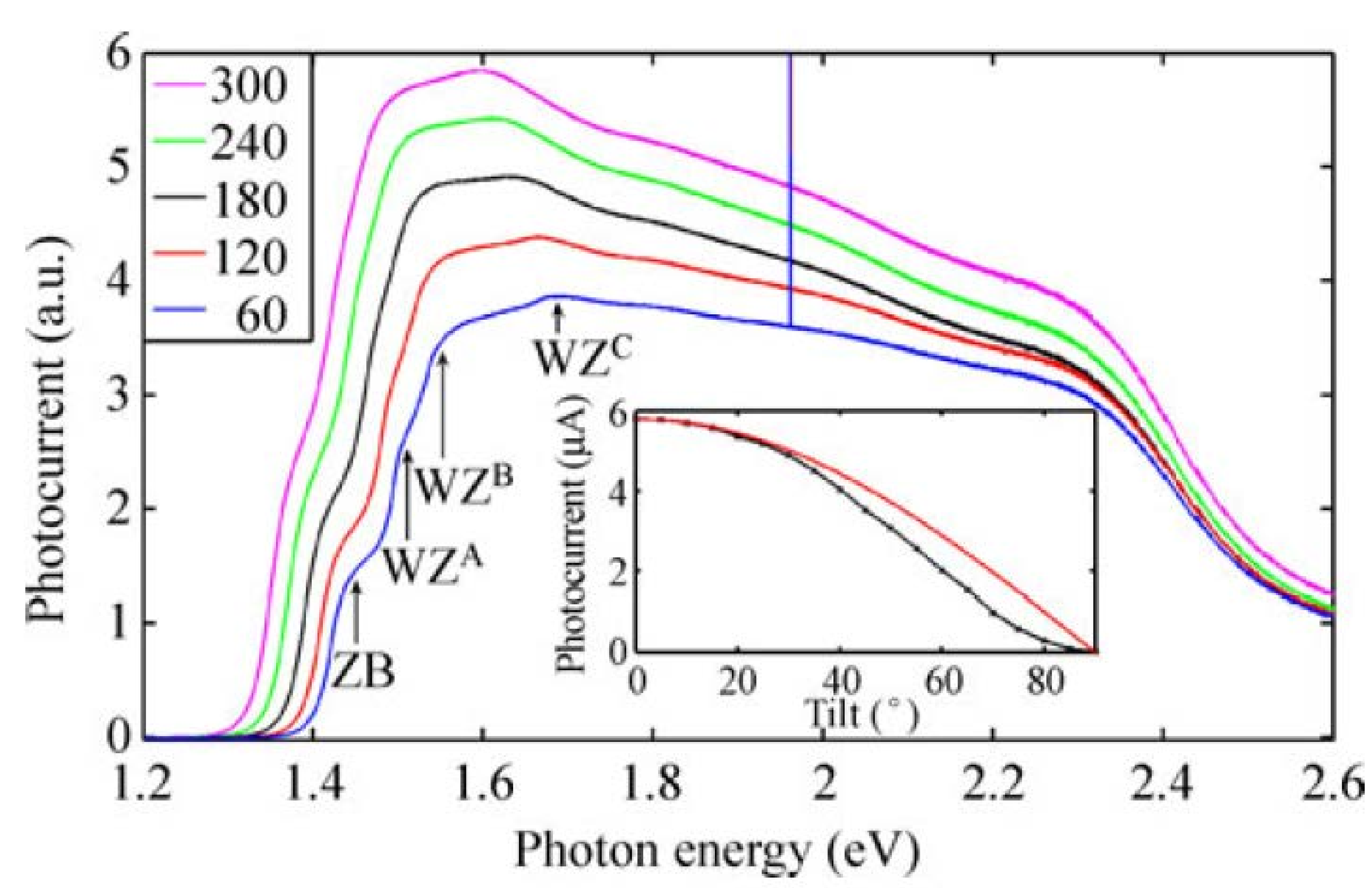
The p-i-n photodetectors (schematics on right-hand side) consist of large ensembles of connected NWs comprising a "p-doped" region, a middle intrinsic (undoped) region, and an "n-doped" region. The term "doping" means adding foreign atoms to the InP crystal during growth. The n-doped regions are electron rich, in contrast to the p-doped regions that lack electrons (hole rich).

Results & Discussion

Incoming photons are absorbed in the i-region, producing electron-hole pairs (see schematics below). These carriers are attracted to the n and p sides, respectively, due to the internal electric field in the device (NWs).



The plot below shows spectrally resolved photocurrent, recorded at different temperatures (in Kelvin), for a NW photodetector comprising one million NWs connected in parallel. The fine structure in the spectra stem from the detailed complex electronic structure of the crystal (InP).



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References

See e.g. V. Jain, A. Nowzari, J. Wallentin, M. T. Borgström, M. E. Messing, D. Asoli, M. Graczyk, B. Witzigmann, F. Capasso, L. Samuelson and H. Pettersson

Study of photocurrent generation in InP nanowire-based p^+–i–n^+ photodetectors

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