Photoresponse study of MWCNTS/insulator/n-type Si/insulator/metal heterostructures as a function of the density of MWCNTs layer

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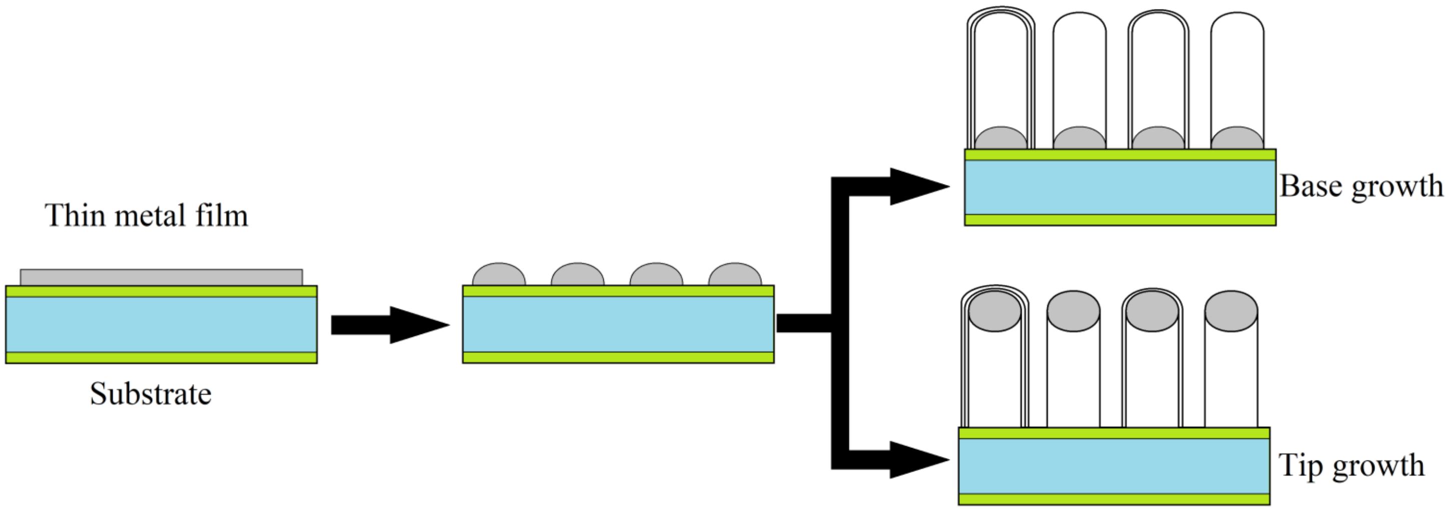
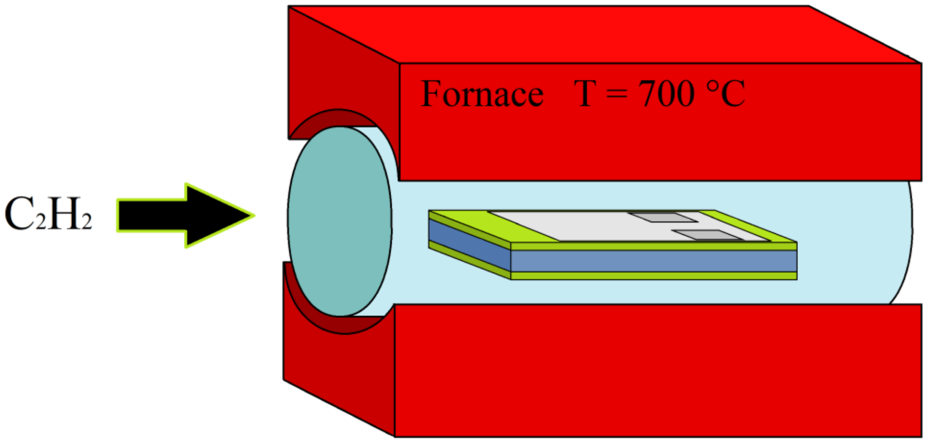
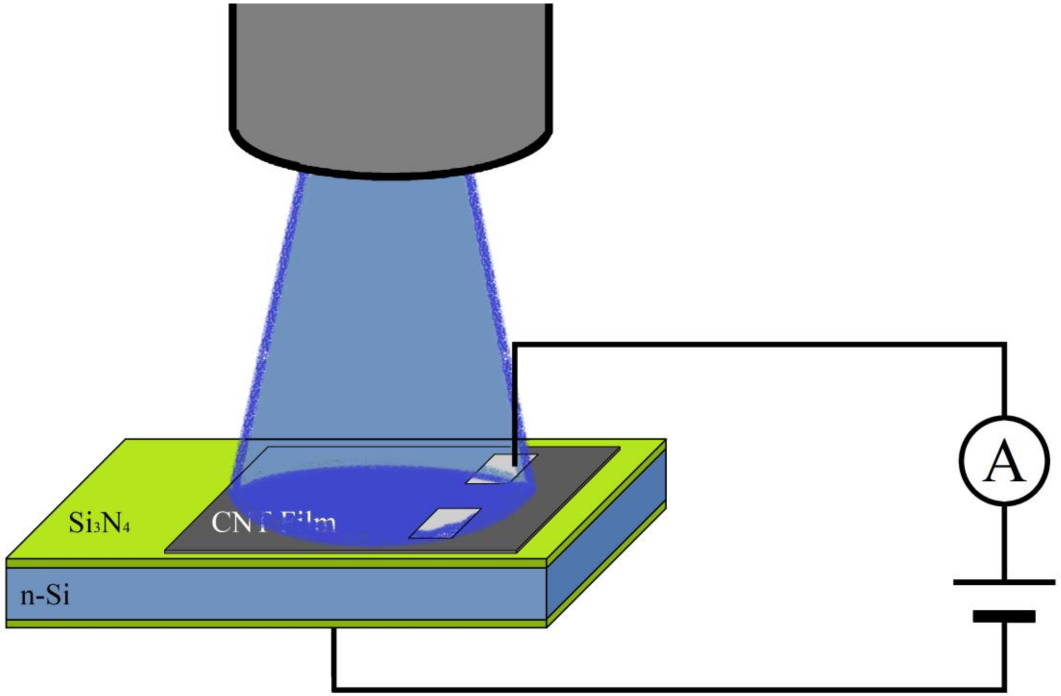
Syntesis method: Chemical Vapor Deposition

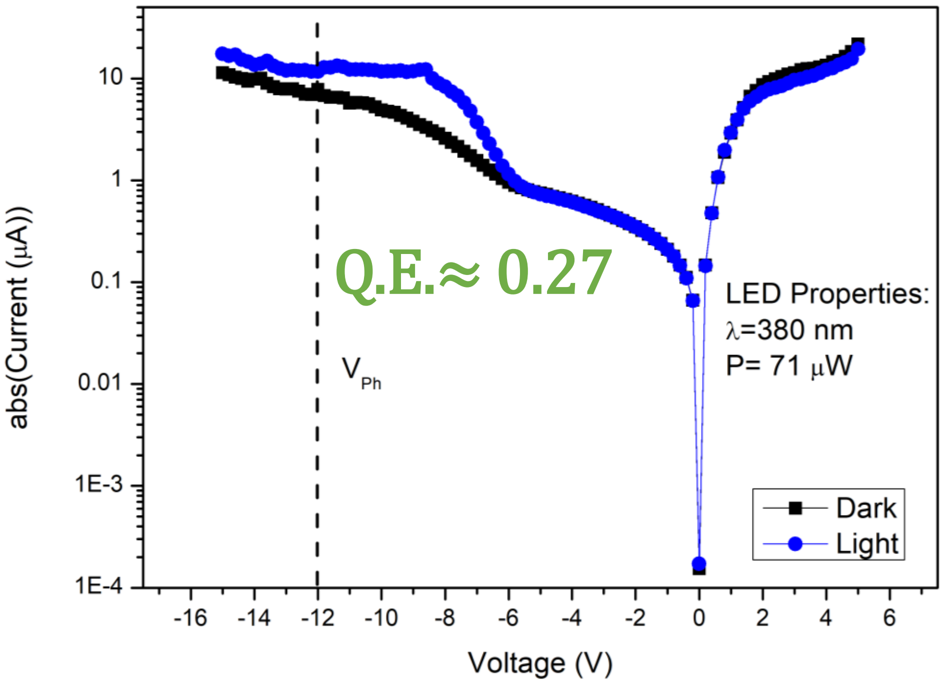




- 500 nm n-type Si (resistivity 1-5 Ωcm, doping ~10^{15} cm^{-3}) with top and back surfaces covered by140 nm Si_3N_4
- Thermal evaporation of 3 nm Ni film
- Thermal annealing to obtain Ni nanoclusters
- Acetylene introduction and CNT growth

Electrical Characterization

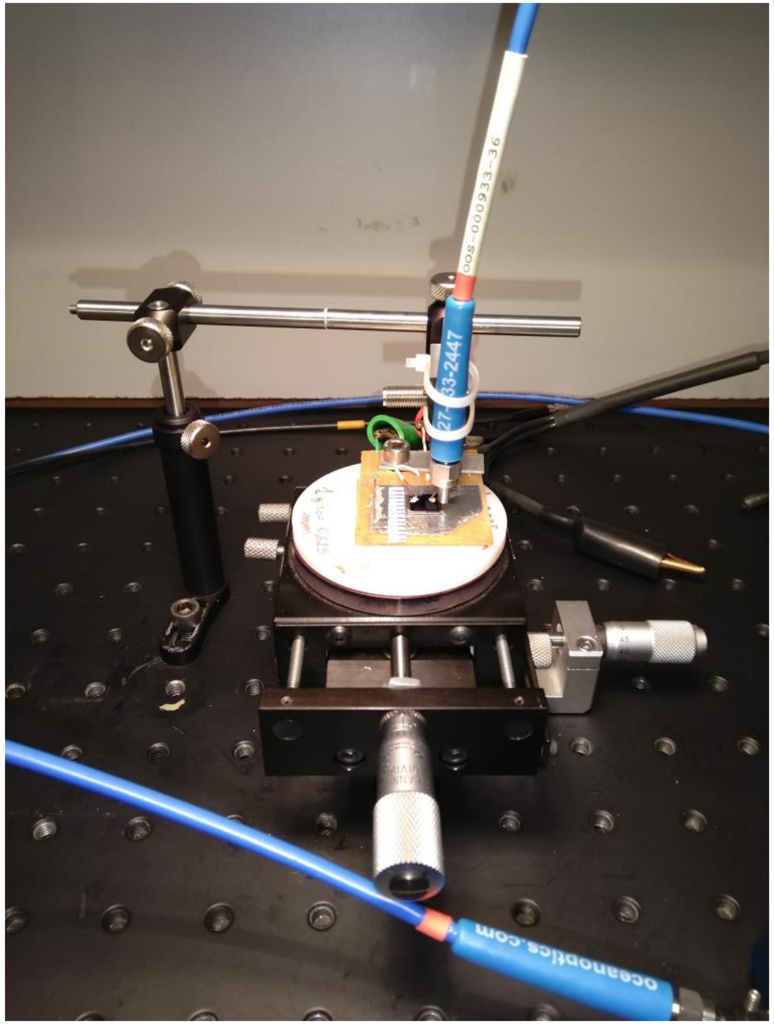


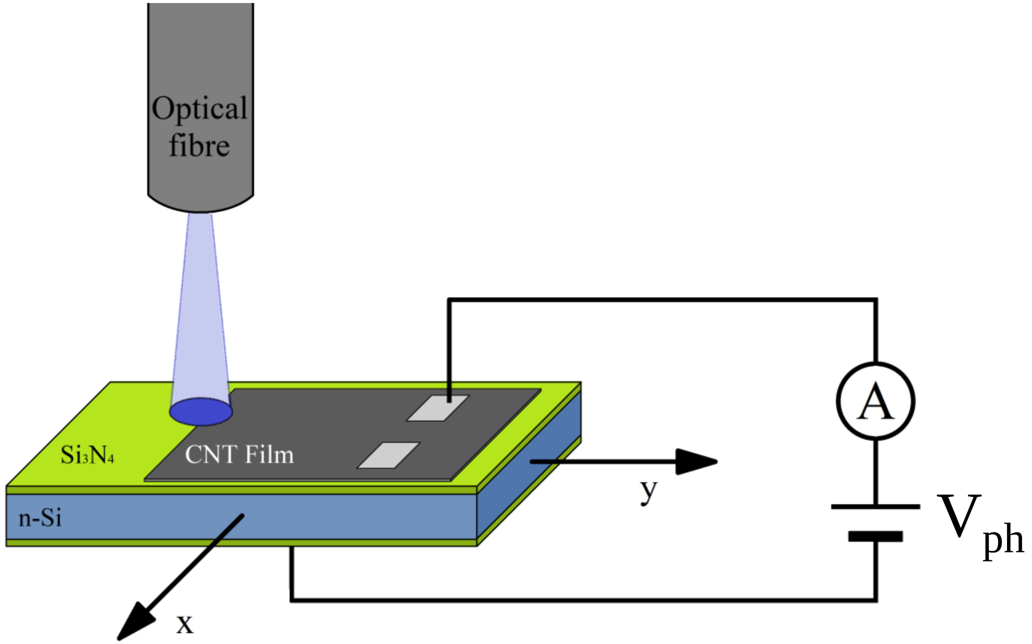


External Quantum Efficiency

$$E.Q.E. = \frac{electron/sec}{photon/sec} = \frac{I_{ph}}{e} \Big/ \frac{P}{E_\lambda} = \frac{I_{ph}\,hc}{eP\lambda}$$

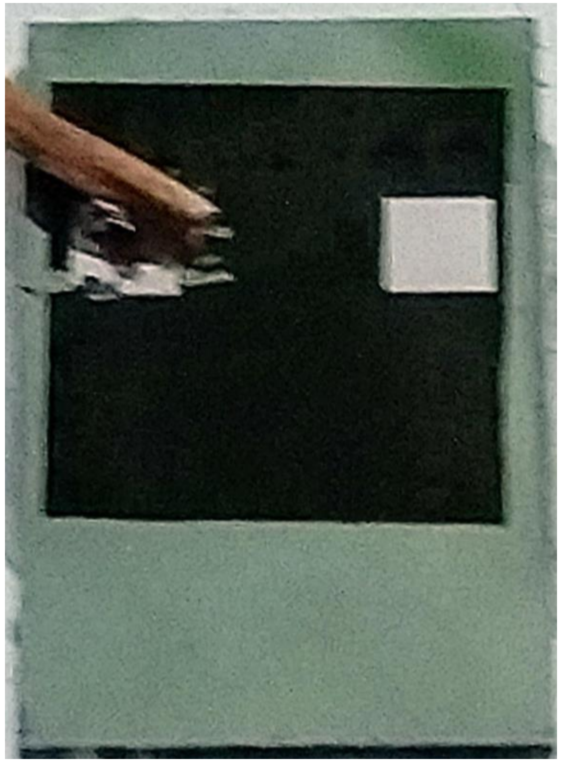
Experimental setup:

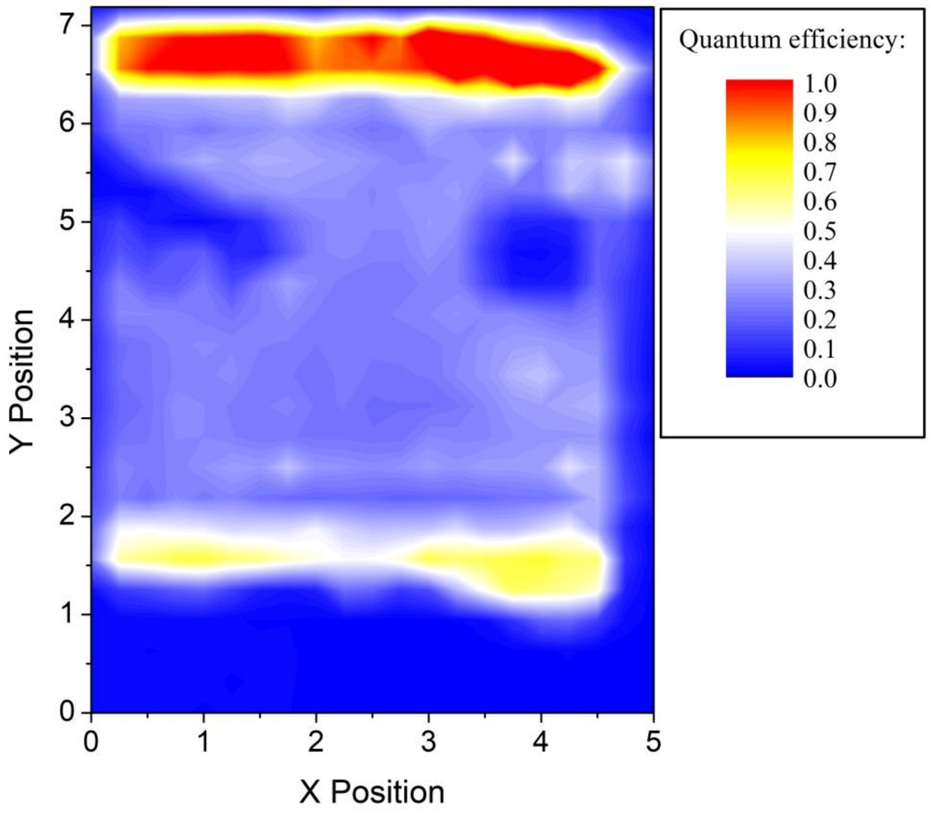




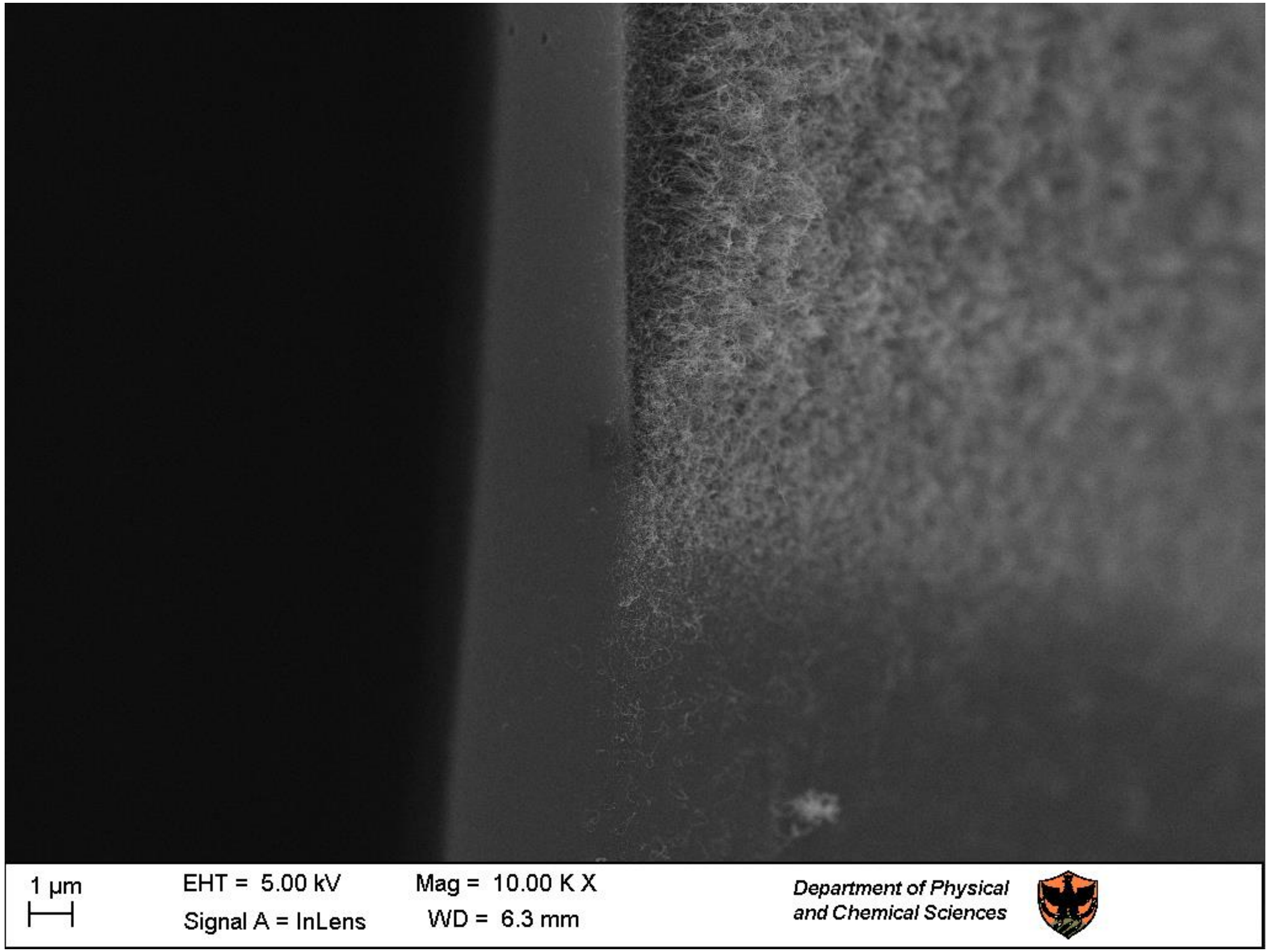
- Sample holder with micrometers screw gauges that allows movements along the x and y directions
- Optical fibre that form a small dot over the sample surface
- LED light: Wavelength λ=380 nm and Power P=70 μW

Sample 1: Q.E. Map



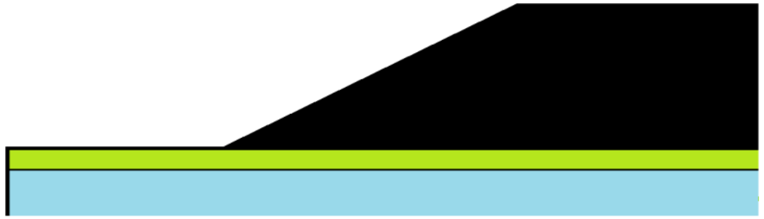


Sample 1: Morphological analysis

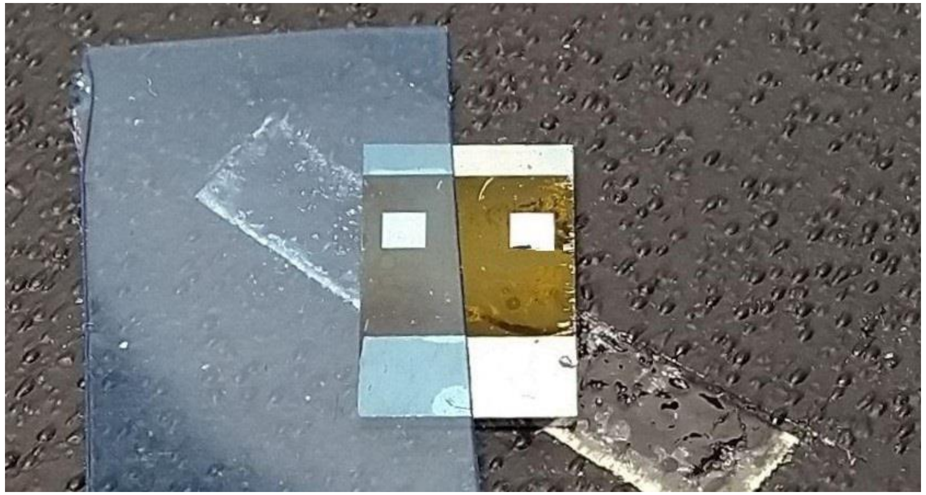


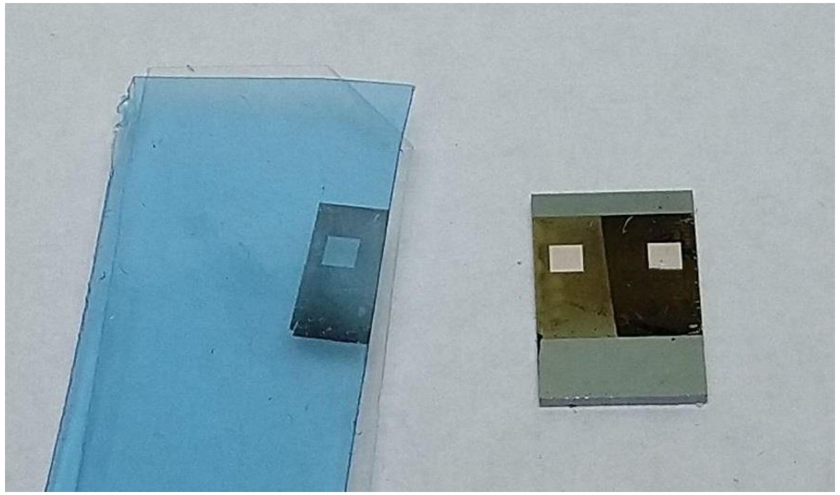
Lateral border

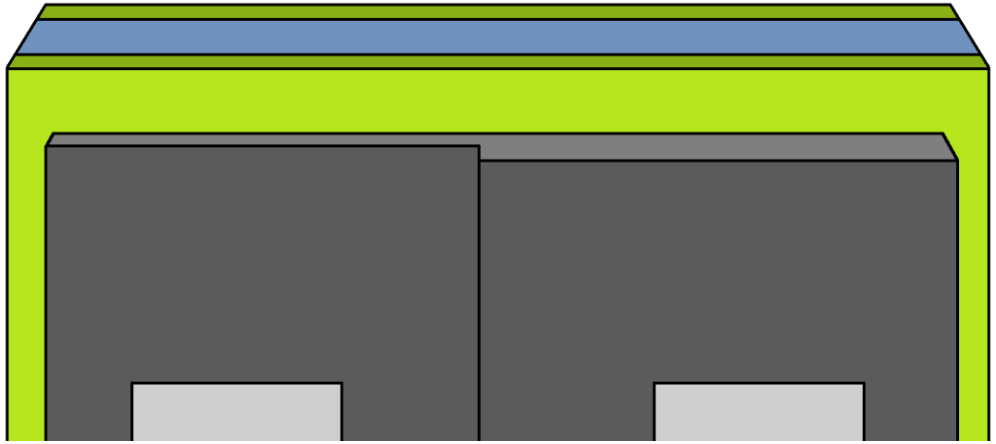
Top and bottom border



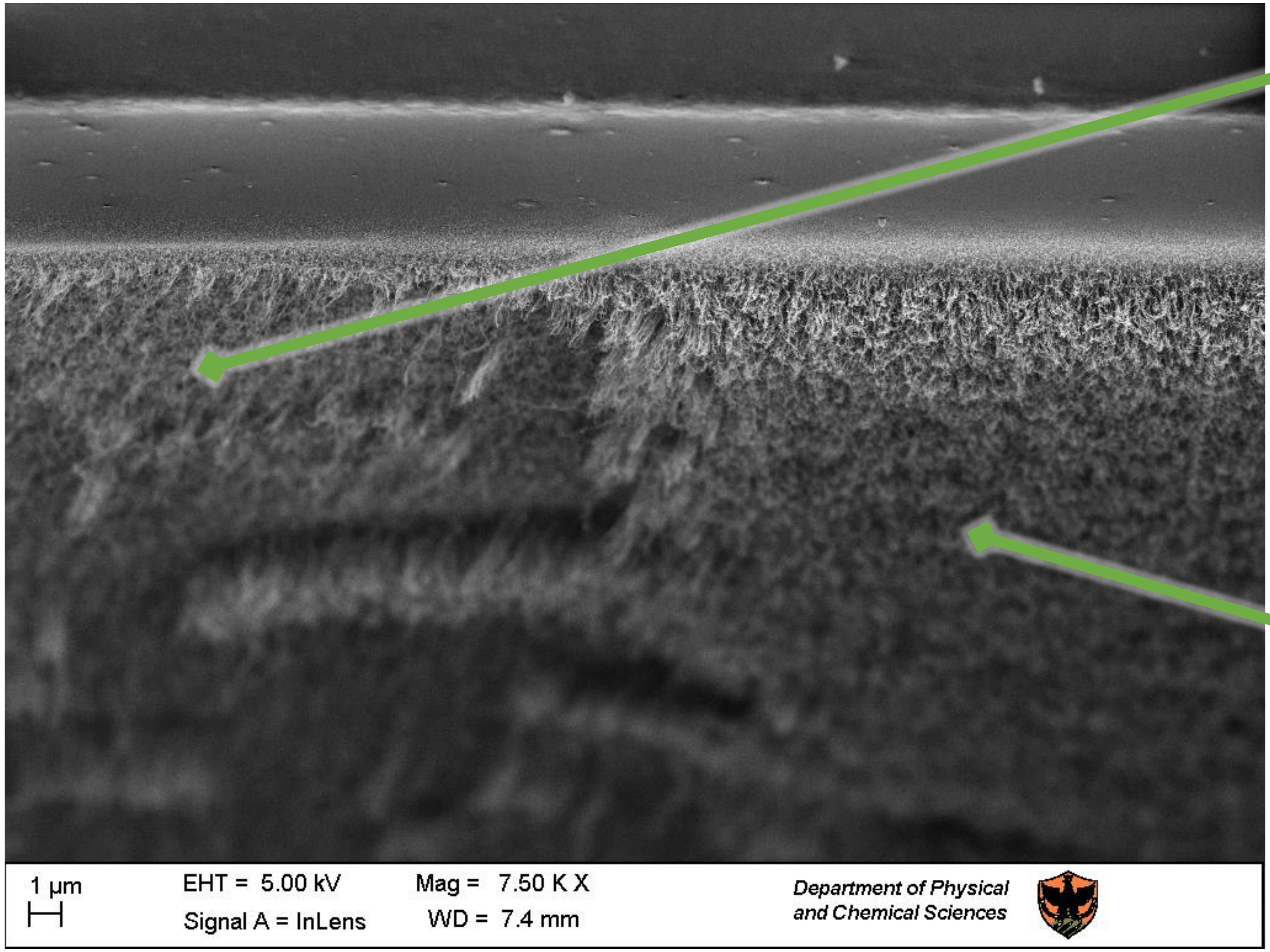
Sample 2: MWCNTs film thickness reduction

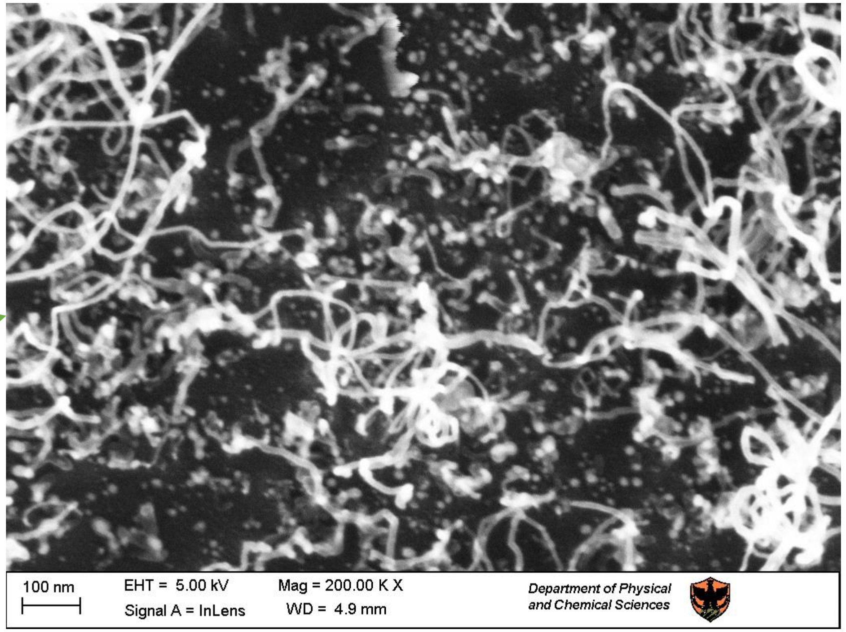


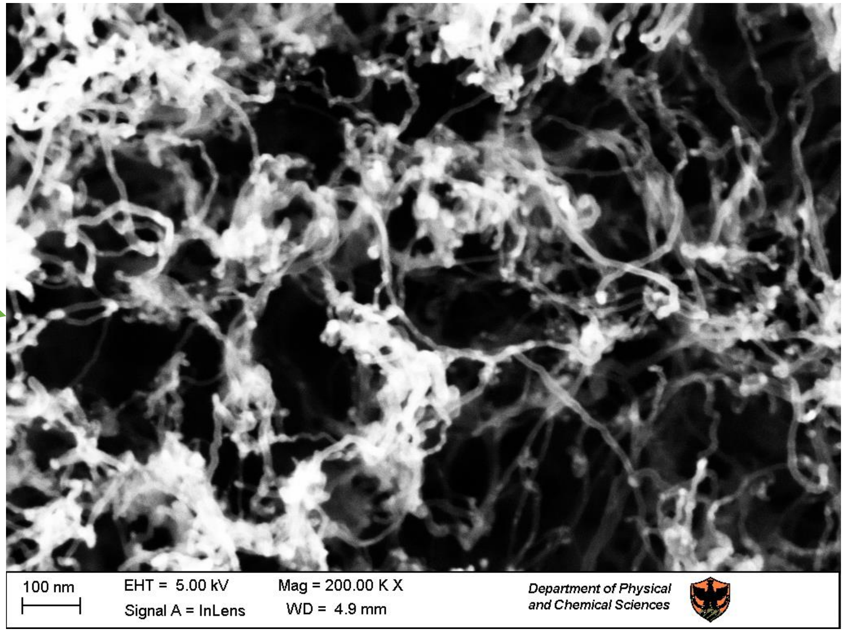




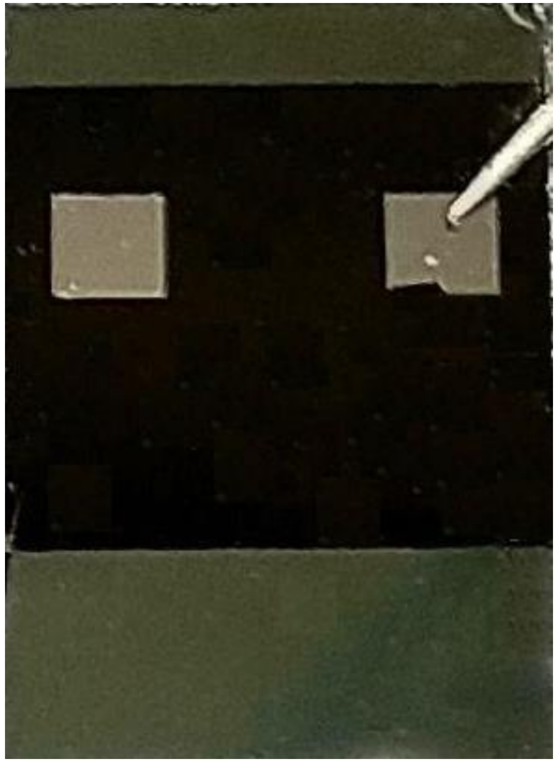
Sample 2: Morphological analysis

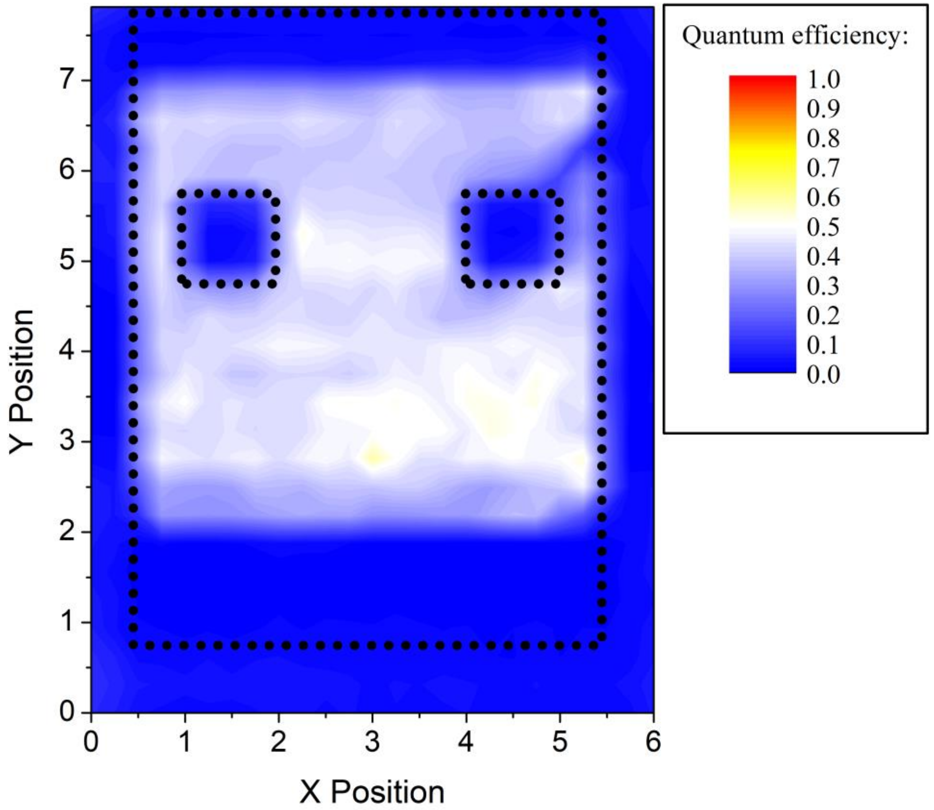




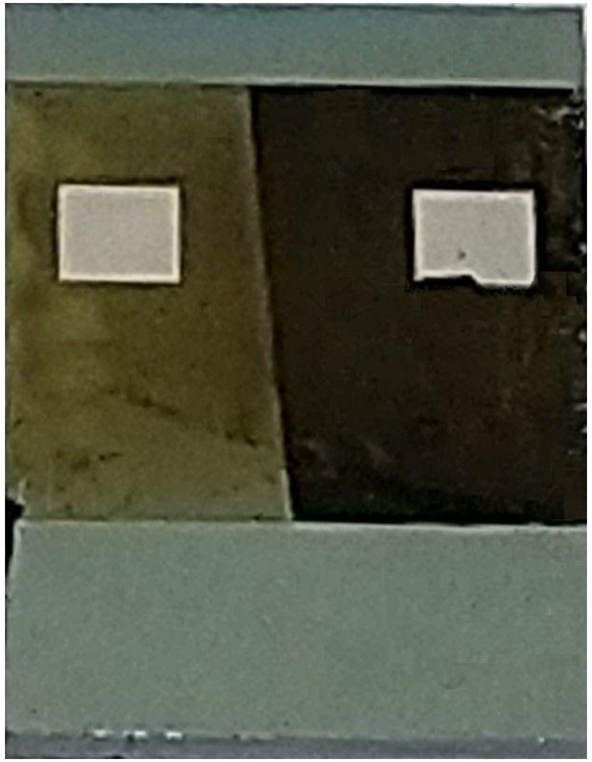


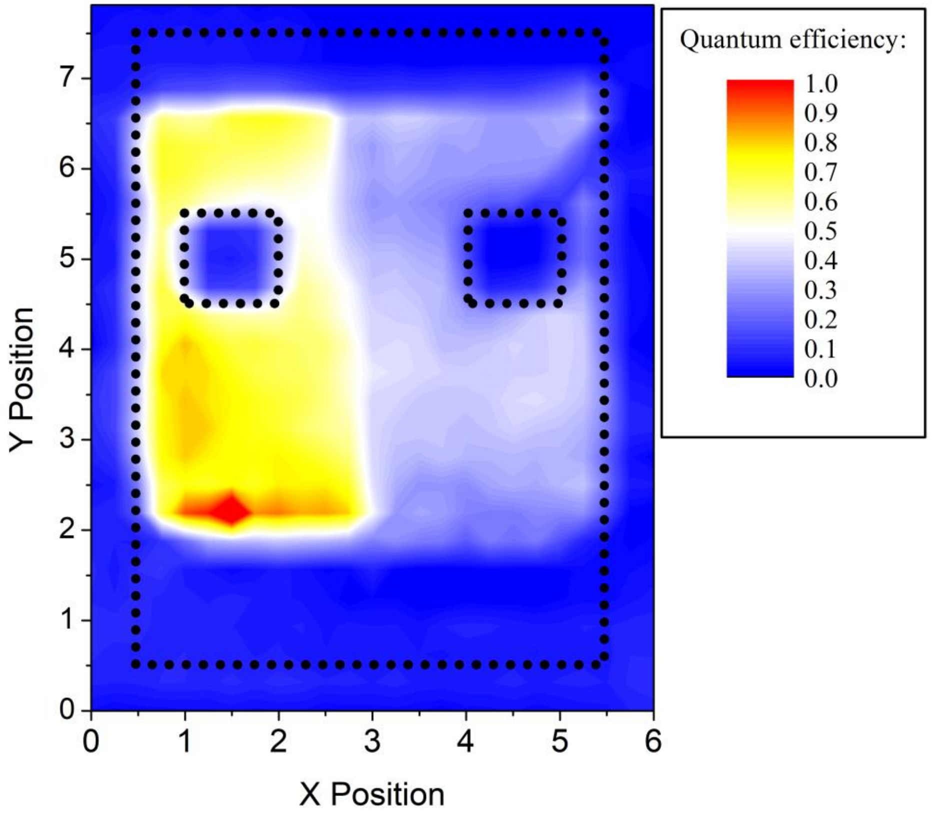
Sample 2: Q.E. Map before remotion



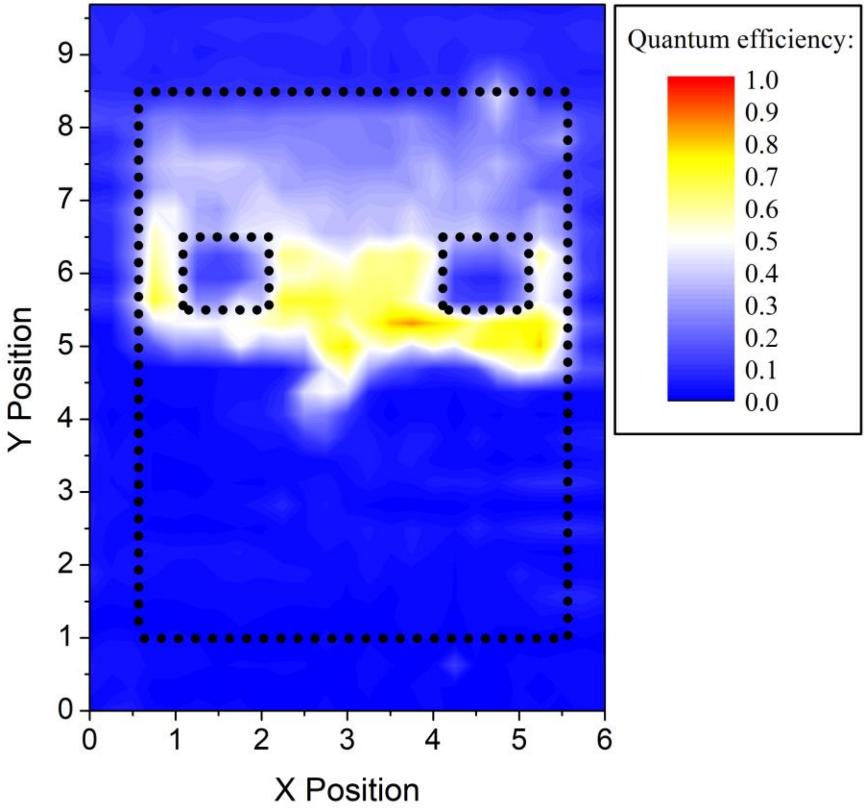


Sample 2: Q.E. Map after remotion



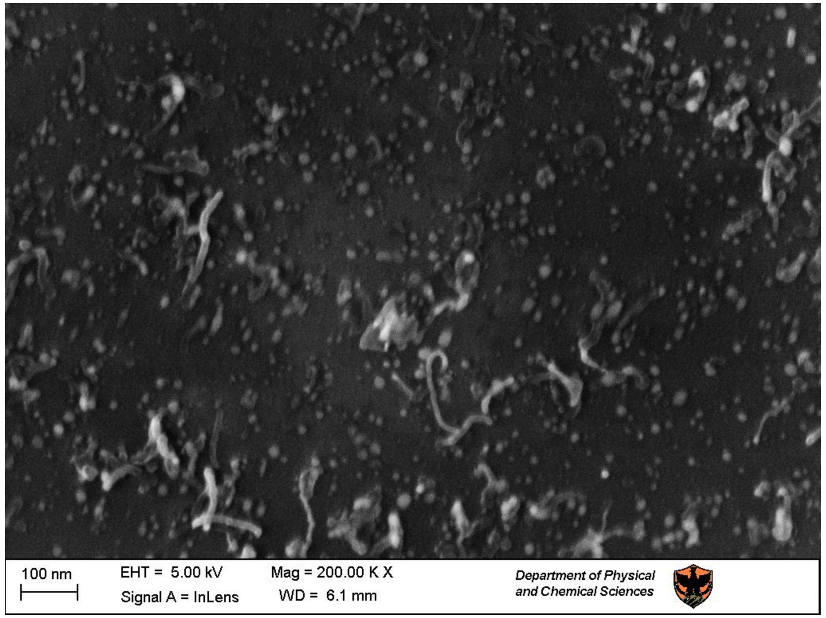


Sample 3: Q.E. Map

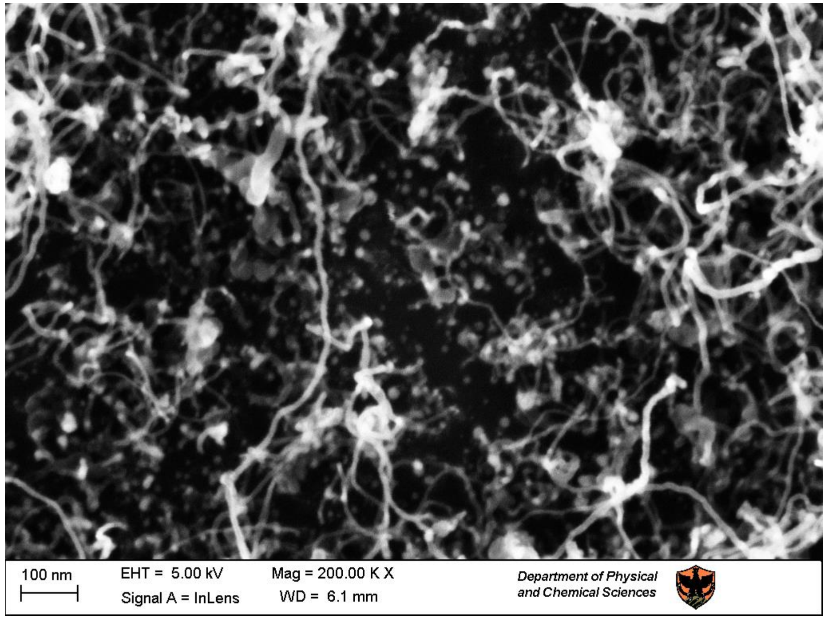


Sample 3: Morphological analysis

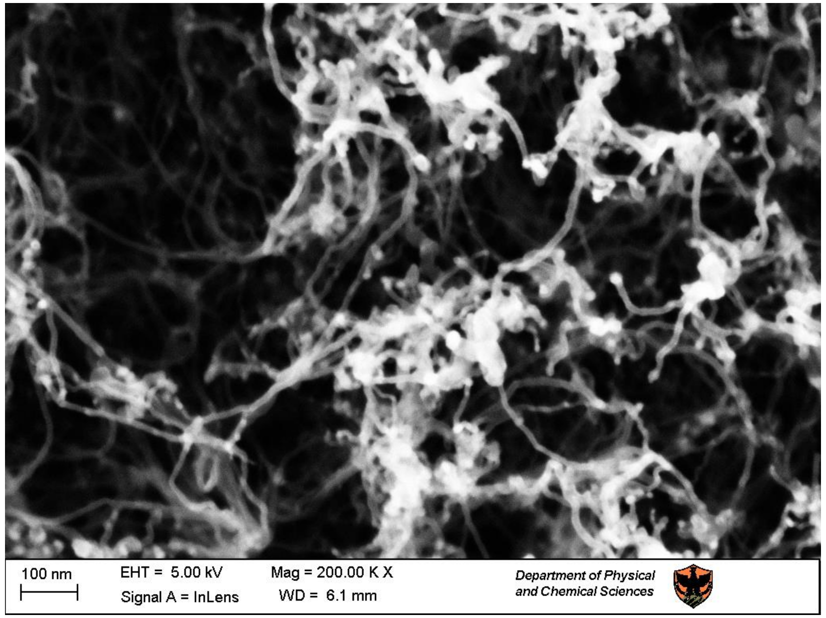
2 remotion



1 remotion



0 remotion



Observation

- A better exposure of the substrate implies an higher values of the photocurrent.
- The photocurrent can be measured only when the MWCNT is illuminated, and only if the nanotubes are electrically contacted to the pads.

Conclusions

- The generation of the photo-charges occurs mostly in the silicon substrate. the MWCNTs film act as a barrier that reduces the number of photon that can actually reaches the substrate.
- The MWCNTs film act as a semi-transparent electrode for photo-charge collection.

Thanks for the attention