The University Of Sheffield.

Semiconductor nanocrystal solar cells

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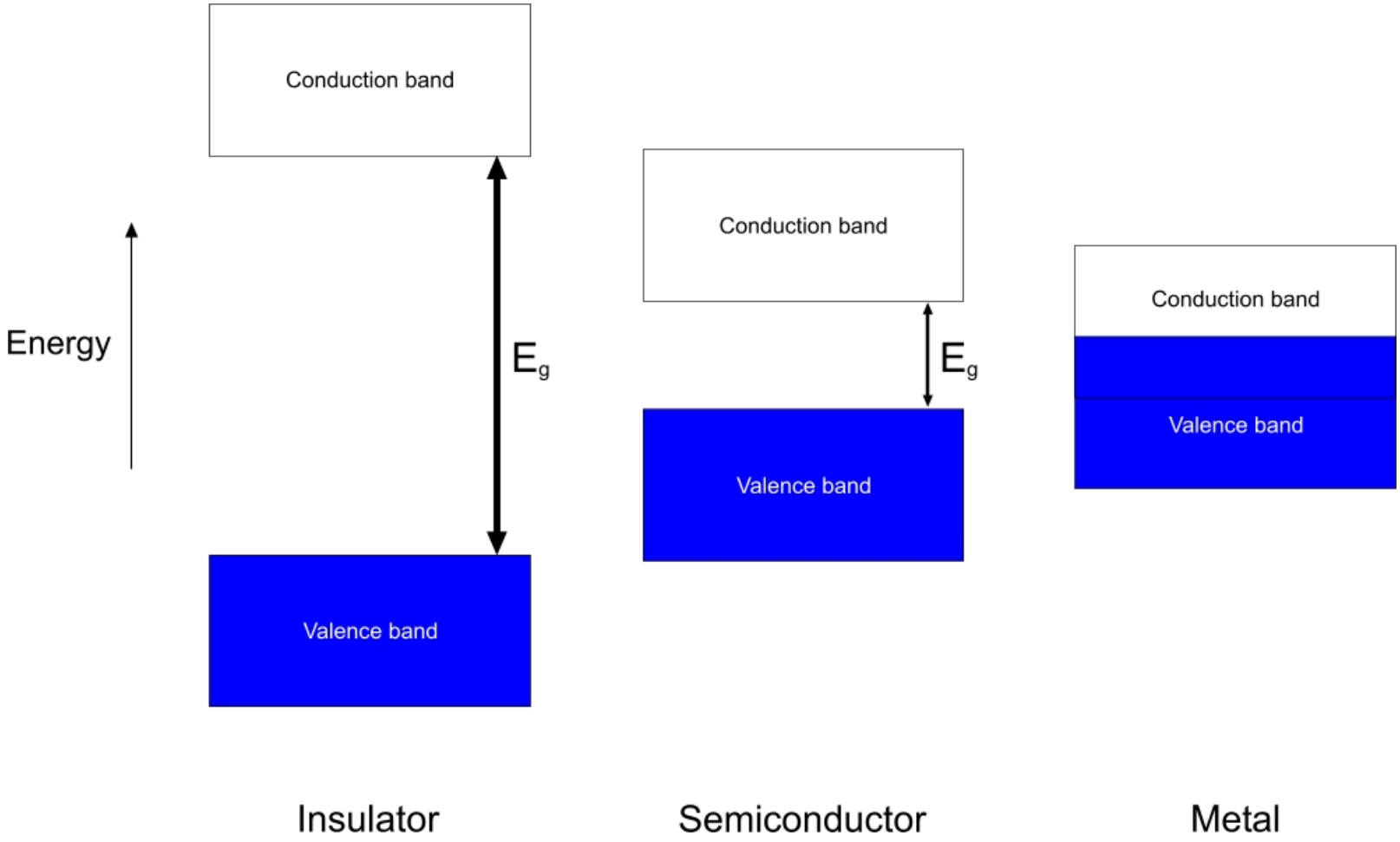
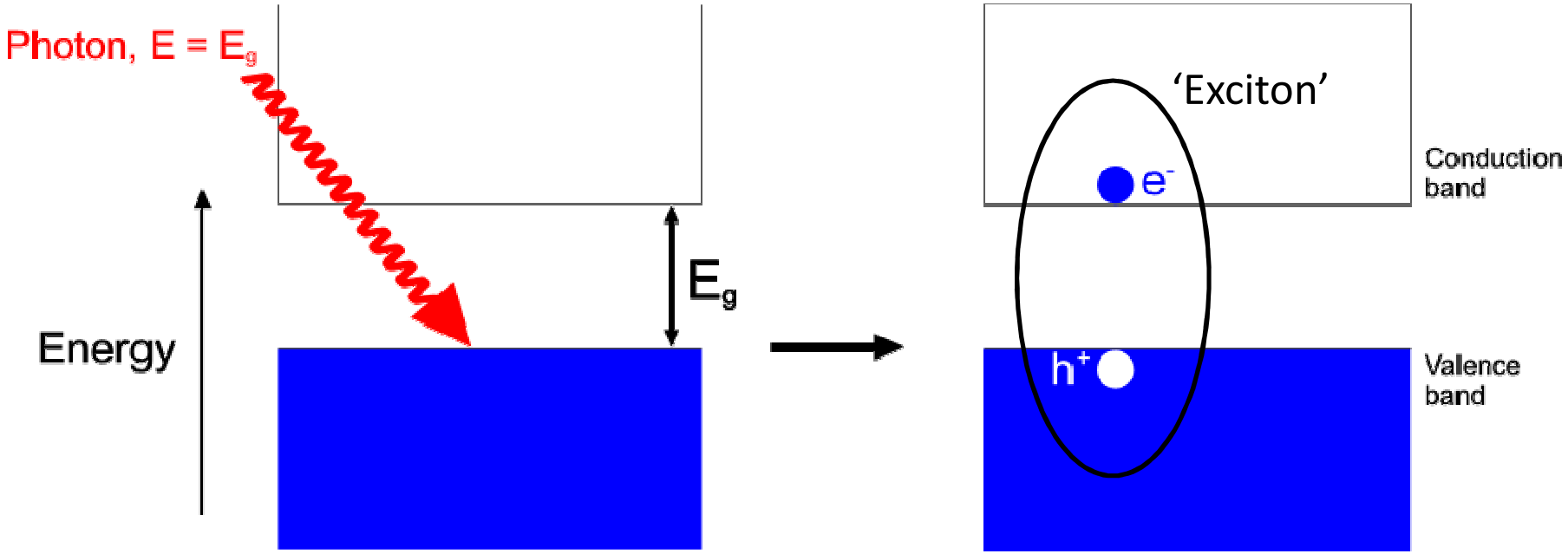
EPSRC
Pioneering research and skills

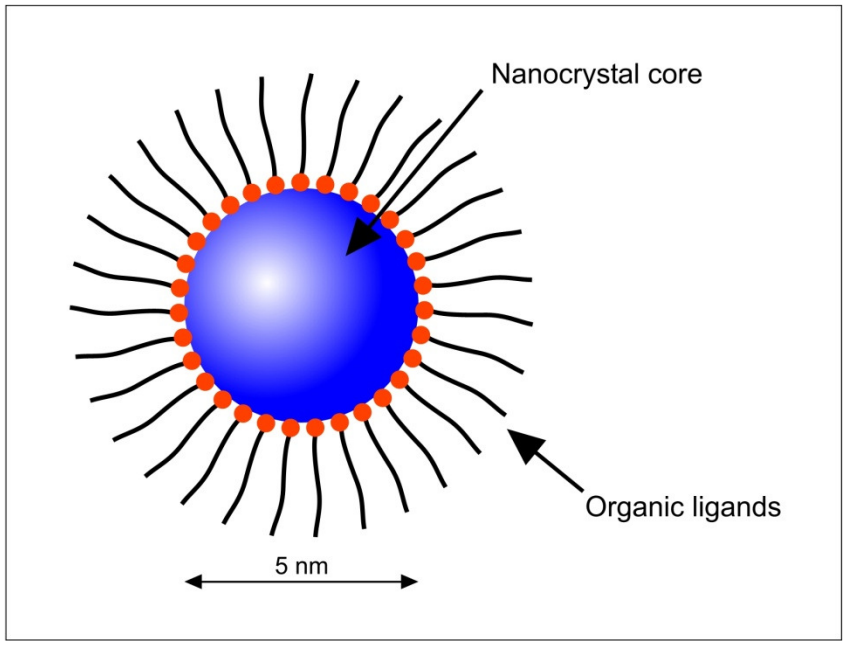
Semiconductors



Photovoltaic effect



Nanocrystals



•A nanoparticle is an object with all three external dimensions in the nanoscale (1-100 nm).

•A nanocrystal is a nanoparticle with a periodic lattice of atoms, ions or molecules.

•Nanocrystals used in this project were cadmium telluride (CdTe), with a diameter of 5nm.

•The nanocrystals are surrounded by organic ligands which help prevent them from aggregating.

Nanocrystals for solar cells

Economic benefits

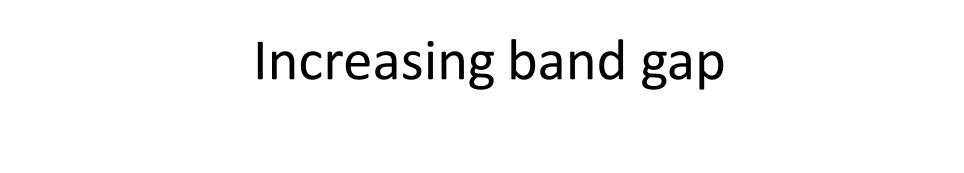
- Small amount of material required
- Simple preparation (solution processing)

Physical effects

- Quantum confinement
- Multiple exciton generation (MEG)

Quantum confinement

Decreasing particle size

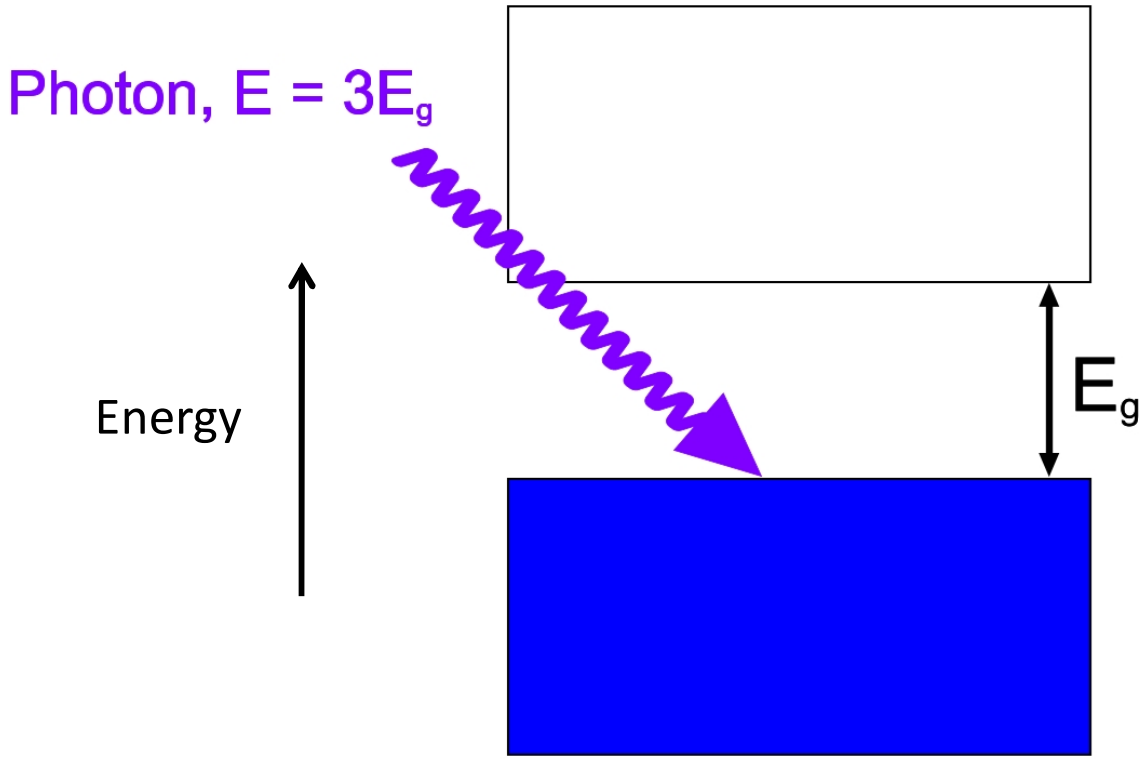


Increasing band gap

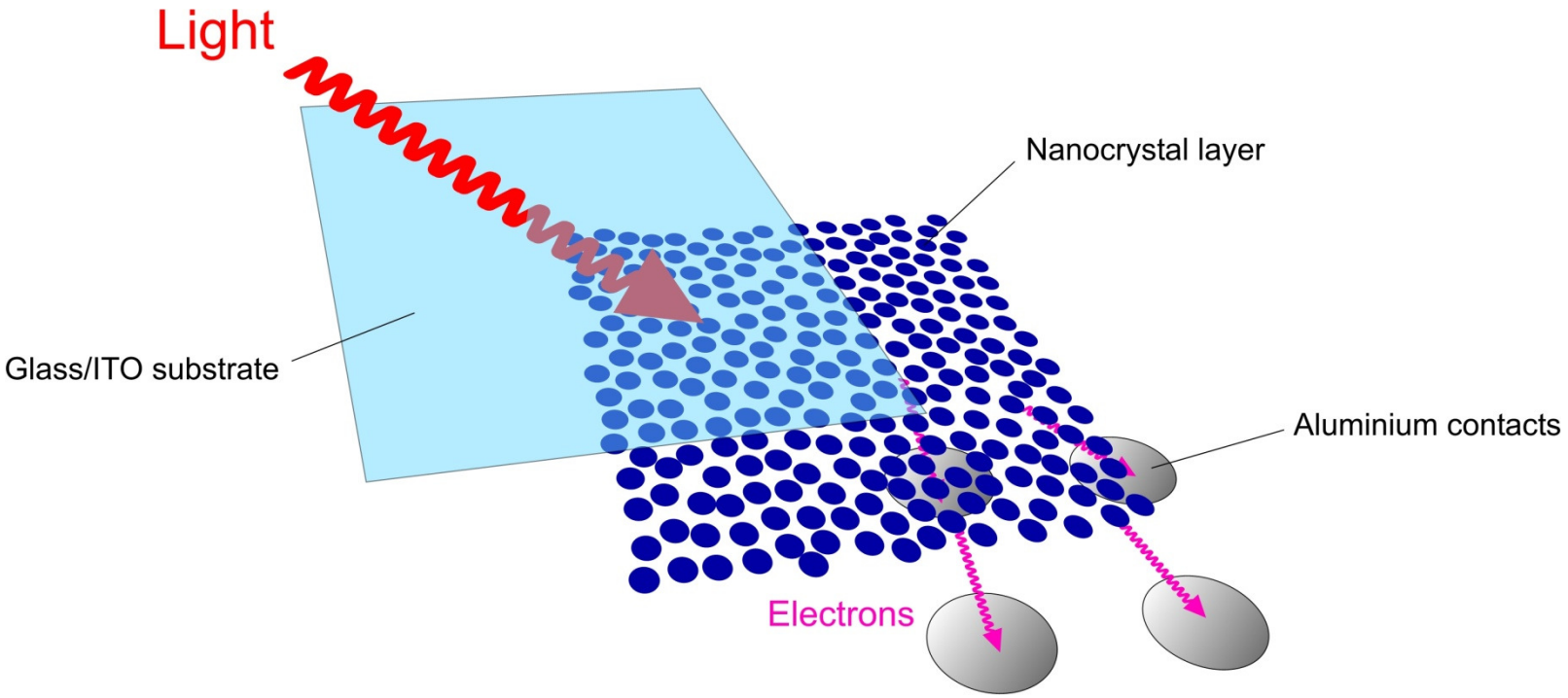
Multiple exciton generation (MEG)

MEG involves the generation of multiple electron-hole pairs upon absorption of a single photon.

Multiple exciton generation (MEG)

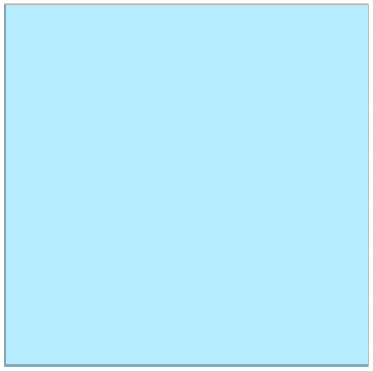


Device structure

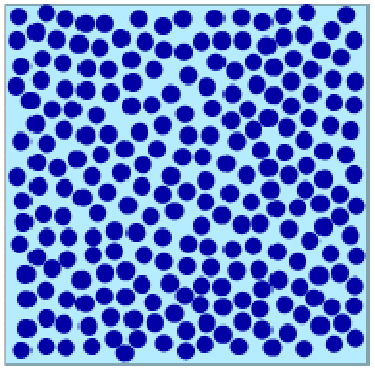


NB – Nanocrystals not to scale!

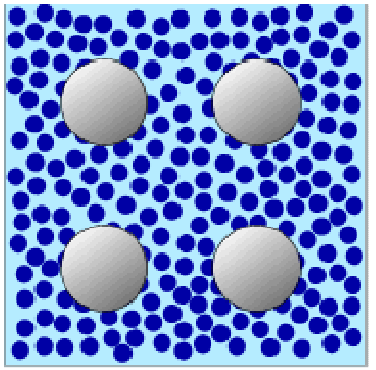
Device structure



Start with ITO-coated glass substrate

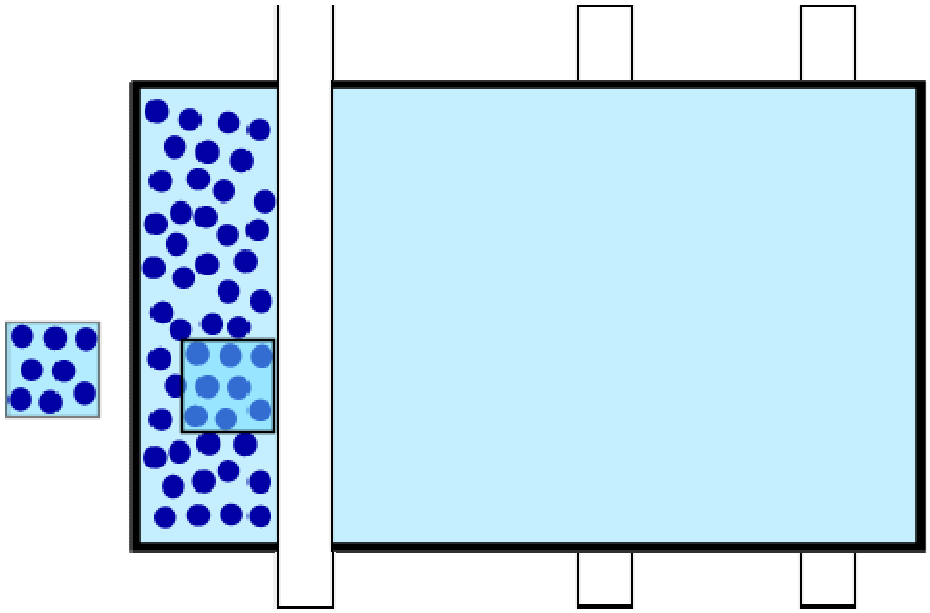


Coat with layers of CdTe nanocrystals

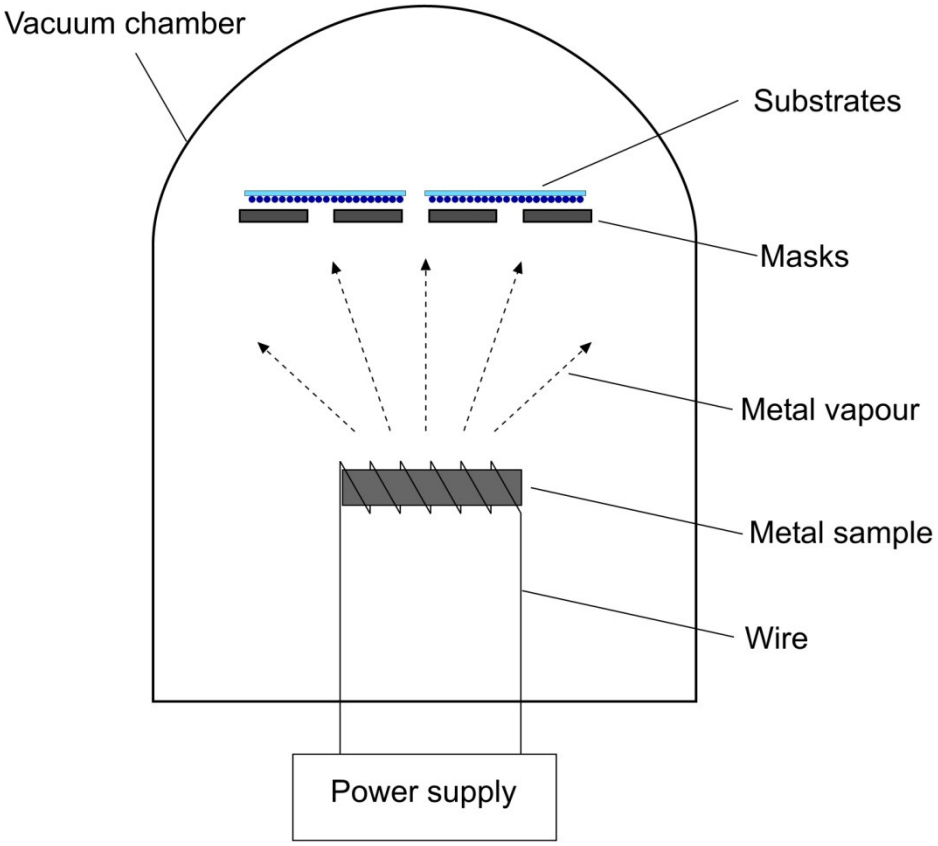


Deposit aluminium contacts

Langmuir-Schaefer technique



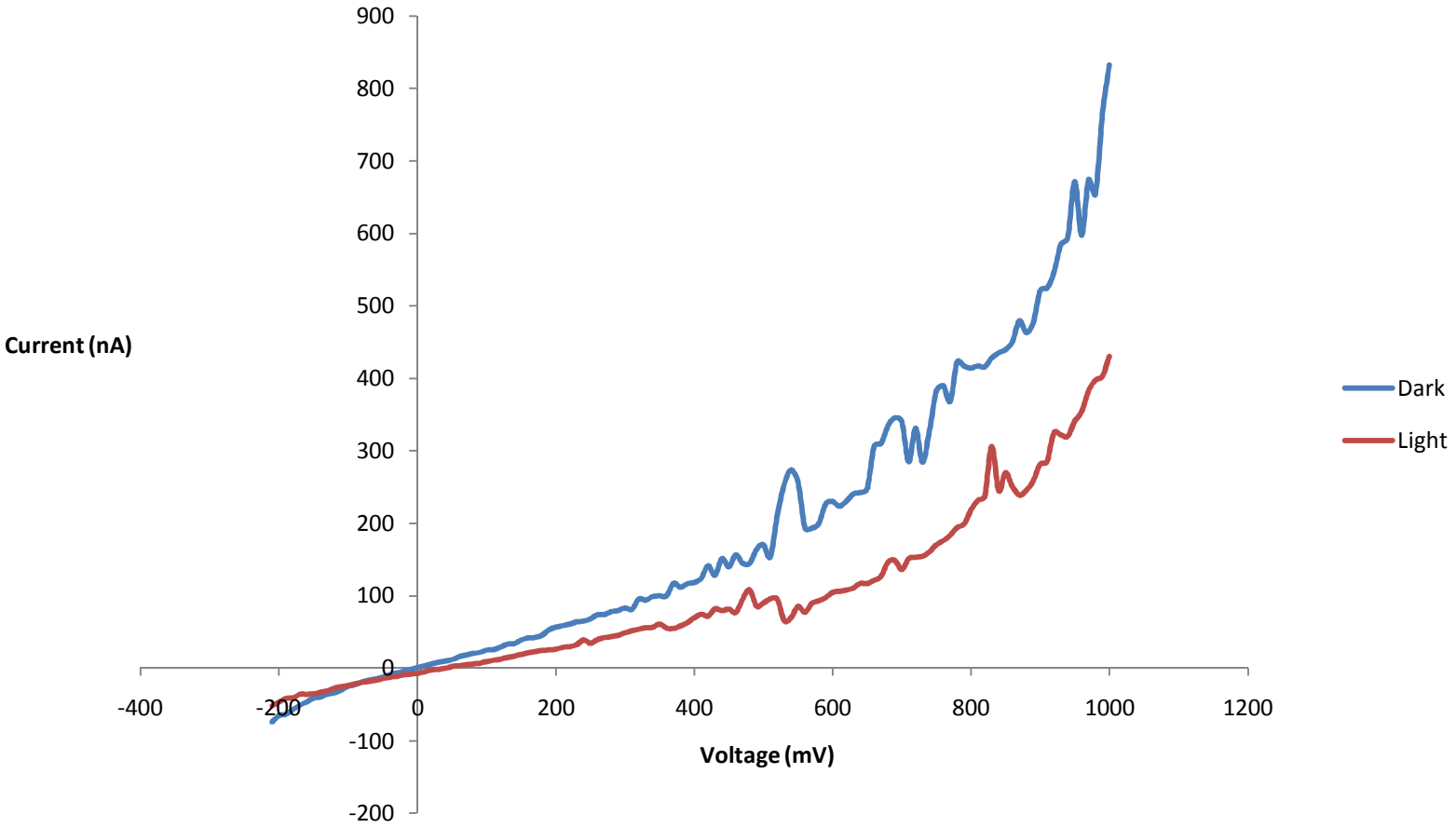
Metal evaporation



Problems

- Producing good nanocrystal films proved difficult
- Evaporating Al contacts produced short-circuits through the film
- CONSISTENCY!

Results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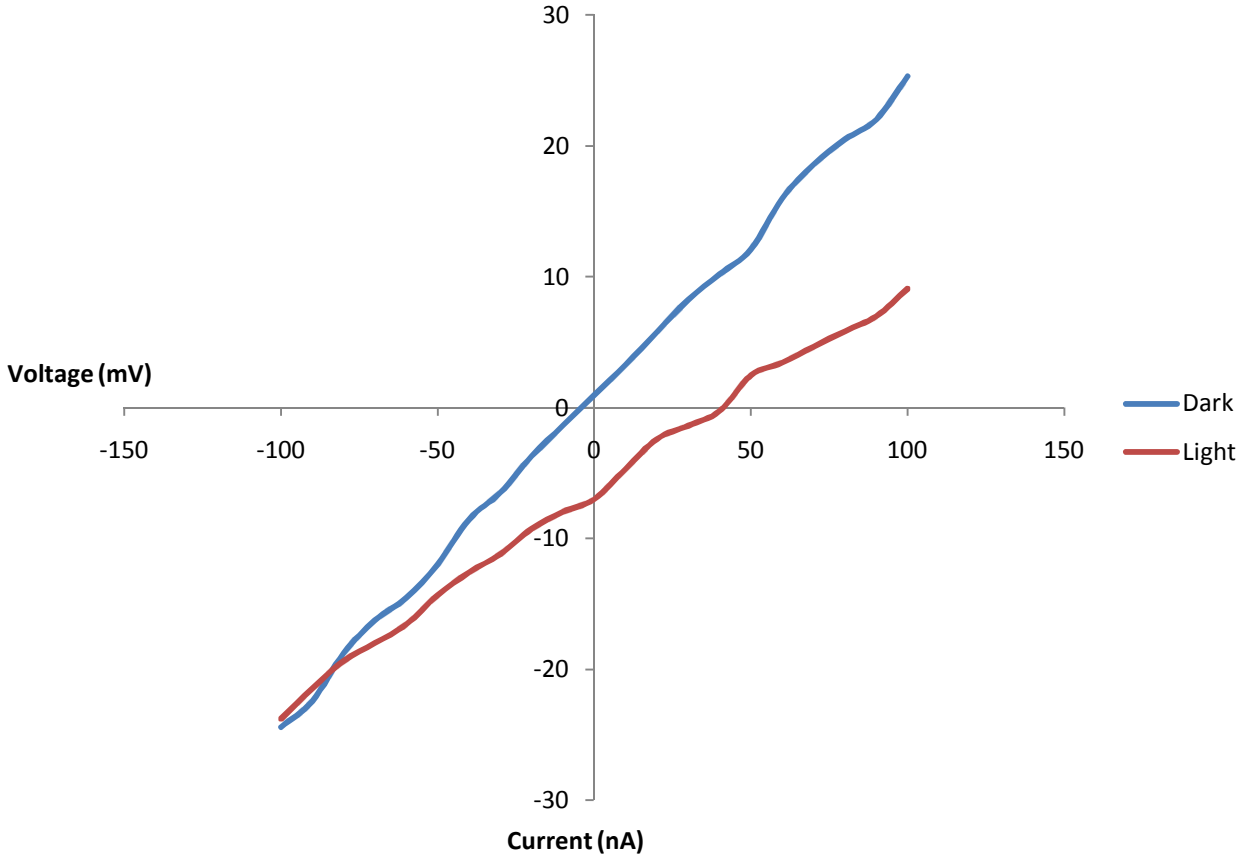
-100
-200
-400
-200
0
200
400
600
800
1000
1200
Current (nA)
Voltage (mV)
Dark
Light

Results


30
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0
-10
-20
-30
-150
-100
-50
0
50
100
150
Voltage (mV)
Current (nA)
Dark
Light

Future work

- Ligand exchange
- MEG
- Gold nanoparticles

Thanks to:

- Nathan Porter
- Dr. Sandall
- Dr. Wilson
- All of you!