

1. Title of Case Study: Designing molecules for light harvesting and charge transport

2. Grant Reference Number or Facility Name: Dr Peter Holliman, Bangor University

3. One sentence summary: Developing large scale, affordable solar panels that could revolutionise the renewable energy industry.

4. One paragraph Summary

Data from the National Crystallography Service (NCS), at the University of Southampton, is helping chemists at Bangor University develop integrated solar panels that could significantly impact our future energy supplies.

5. Key outputs in bullet points:

NCS data is enabling:

- Researchers to develop a significant alternative to silicon solar panels
- The potential production of integrated printable solar panels
- An alternative way of capturing Earth's abundant solar energy
- Academics at Bangor University to fully explore their research and achieve a high quality publishable standard
- The translation of research into real-world applications that could revolutionise our society

6. Main body text

Data from the National Crystallography Service (NCS), at the University of Southampton, is helping chemists at Bangor University develop integrated solar panels that could significantly impact our future energy supplies.

"Without the NCS it would be impossible for us to continue with our work at the same pace. We wouldn't be able to get the data we require to proceed and it would be much more difficult to get our work published. If we can't publish anything, our project would grind to a halt, so the NCS is very, very important to us," said Project leader Dr Peter Holliman, Reader in Inorganic Chemistry at Bangor University.

Addressing climate change is one of the biggest challenges facing our society today and Peter and his team are exploring research that could provide a key solution to harvesting the Earth's abundant supply of solar energy.

Peter said: "At Bangor we are investigating the production of printable solar cells that offer the potential for large scale manufacturing to drive down costs and increase uptake.

"Working closely with Professor Dave Worsley's materials engineering group at SPECIFIC Innovation Knowledge Centre, at Swansea University, my team has been developing building integrated photovoltaics (BIPV) – solar cells containing new light harvesters for dye-sensitised solar cells and molecular charge carriers that can efficiently transport captured charge to device electrodes.

"By integrating these cells into commercial and domestic buildings and installing them with the roof or walls, the installation costs will be significantly reduced.

"However, solar cells are multi-layer devices and speeding up manufacturing means that each layer of the device needs to rapidly self-assemble on the previous layers to create a perfect molecular jigsaw.

"In order to be able to do this all the components need to be compatible with each other and this is where we need the NCS' single crystal X-ray diffraction to identify the molecular structures of each part of the solar cell jigsaw. This data allows us to design molecules that optimise the way they fit together.

"We don't have these facilities at Bangor, we need the powerful equipment at the NCS."

Peter sends about 20 samples to the NCS every year and has been using the service for the past five years.

"This data is allowing us to continue our research that could have a major impact on the solar industry," said Peter.

"There is a phenomenally abundant supply of solar energy. One day's solar energy is enough to power the Earth for 27 years. What we are trying to do is to develop a way to harvest that energy in an effective, low-cost, high-production way.

"Our work with the NCS is an integral part of helping us translate our research into real-world applications," he added.

Recent publications include:

Ultra-fast Co-Sensitization and Tri-Sensitization of Dye-Sensitized Solar Cells with N719, SQ1 and Triarylamine Dyes P.J. Holliman, M. Mohsen, A. Connell, M.L. Davies, K. Al-Salihi, M.B. Pitak, G.J. Tizzard, S.J. Coles, R.W. Harrington, W. Clegg, C. Serpa, O.H. Fontes, C. Charbonneau, M.J. Carnie, *J. Mat. Chem.*, 2012, **22**(26), 13318-13327. **DOI:** 10.1039/C2JM31314F

A Study of Dye Anchoring Points in Half-squarylium Dyes for Dye-Sensitized Solar Cells. Arthur Connell, Peter J. Holliman, Matthew L. Davies, Christopher D. Gwenin, Sophie Weiss, Mateusz B. Pitak, Peter N. Horton, Simon J. Coles, Graeme Cooke, *J. Mater. Chem. A*, 2014, **2**(11), 4055 - 4066. **DOI:** 10.1039/C3TA15278B

Multiple linker Half-squarylium Dyes for Dye-Sensitized Solar Cells; Are Two Linkers Better than One? Arthur Connell, Peter J. Holliman, Eurig W. Jones, Leo Furnell, Christopher Kershaw, Matthew L. Davies, Christopher D. Gwenin, Mateusz B. Pitak, Simon J. Coles and Graeme Cooke, *Journal of Materials Chemistry A*, 2015, **3**, 2883-2894. **DOI:** 10.1039/c4ta06896c.

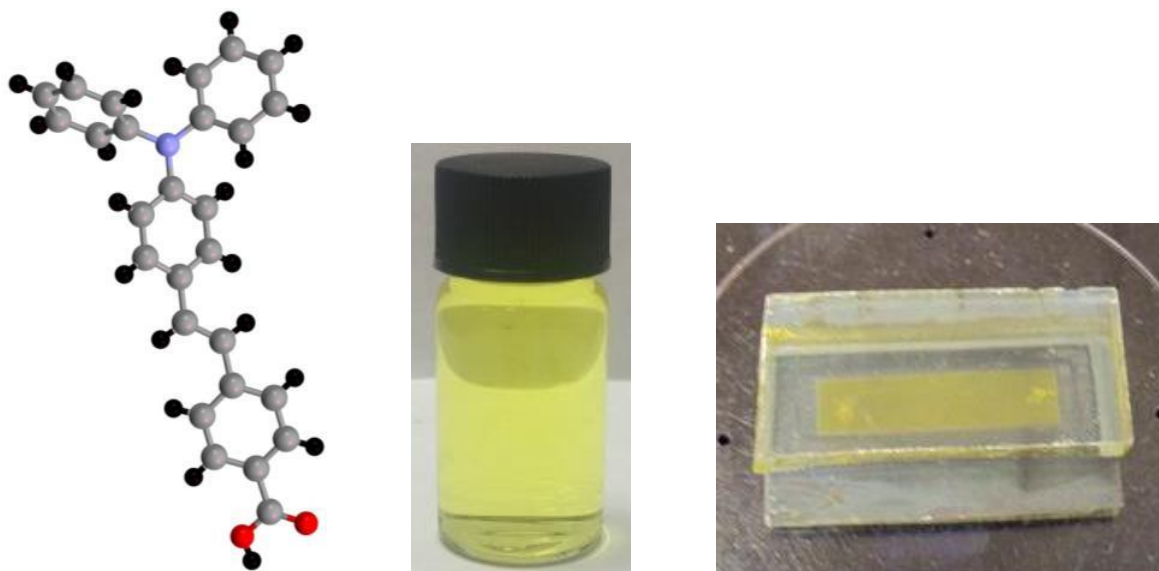


Fig. 1 Single crystal structure of (left) yellow, triphenylamine dye, (middle) yellow dye solution and (right) the corresponding yellow dye sensitized solar cell.

7. Names of key academics and any collaborators:

Dr Peter Holliman and research team, School of Chemistry, Bangor University, Bangor
Professor Dave Worsley, SPECIFIC, Swansea University, is a key collaborator

8. Sources of significant sponsorship (if applicable):

EPSRC

"Sustainable Product Engineering Centre for Innovative Functional Industrial Coatings – SPECIFIC". Dr Peter Holliman is Bangor PI working with Prof Worsley in Swansea (EP/I019278/1). £466,000.

"Stabilising chromophores and pigments". Dr Peter Holliman PI CASE PhD studentship. £85,000.

"*Self-assembled perovskite absorbers – cells in modules*". Dr Peter Holliman is PI with Prof Henry Snaith (Oxford Physics) and Prof Dave Worsley/Dr Trys Watson, Swansea (EP/M015254/1). £3.20m

Welsh Government

"*Ser Cymru Solar – researching printable solar cells*". Dr Peter Holliman is Bangor PI with Prof Dave Worsley (SPECIFIC, Swansea) and Prof James Durrant (Imperial College/Swansea). £553,000.

"*Self-assembling Nanolayer Materials for Advanced Devices*". NRN funded PhD studentship. Dr Peter Holliman is PI with Prof Dave Worsley/Dr Cecile Charbonneau (SPECIFIC Swansea), Dr Chris Gwenin (Bangor), Dr Vincent Barrioz (Glyndŵr) and GCell, Newport. £60,000.

9. Who should we contact for more information?

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