



NECEM SEMINAR: Integrated Spectral Conversion Materials for Luminescent Solar Devices

Dr Rachel C. Evans, University of Cambridge

14:00pm-15:00pm, Wednesday 20th February 2019

Newcastle University, Bedson Building, Lecture Theatre 2.76

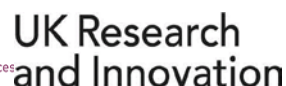
Refreshments available after the seminar in the Faraday Room (Bedson Building 1st Floor)

Integrated Spectral Conversion Materials for Luminescent Solar Devices

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Single junction photovoltaic devices exhibit a bottleneck in their efficiency due to incomplete or inefficient harvesting of photons in the low- or high-energy regions of the solar spectrum. This can be overcome through the retro-fitting of a spectral converter to the device, which is used to convert solar photons into energies that are more effectively captured by the solar cell through a photoluminescence process.^[1] However, while a lumophore may show seemingly ideal optical characteristics for spectral conversion in an ideal solution (high emission quantum yield, strong absorption), disappointment frequently awaits on its translation to the solid-state, where aggregation and quenching effects lead to significantly reduced photoluminescence yields.

In an effort to overcome this limitation, our research focusses on the bottom-up design of integrated lumophore-host materials for solar spectral converters, in which materials chemistry design strategies are used to control the packing, orientation and placement of π -conjugated lumophores in solid-state host materials. Since the electronic properties depend explicitly on the arrangement and packing of the π -conjugated species, this approach provides a means of modulating the optical properties. In this talk, I will report our recent results on the design of π -conjugated composite materials that utilise a family of organic-inorganic hybrid polymers known as the *ureasils* as the host.^[2] Ureasils are comprised of a siliceous skeleton that is chemically-grafted to poly(ethylene oxide) (PEO)/poly(propylene oxide) (PPO) chains through urea cross-linkages, the number of which depends on the degree of branching in the organic polymer precursor. Ureasils are intrinsically photoluminescent,^[3] exhibit high refractive indices and function as optical waveguides.^[4] Through judicious selection of the degree of branching and length of the organic backbone and the incorporation method (grafting vs immobilization vs permeation), we can control the packing,



orientation and placement of the π -conjugated species in the ureasil host. This in turn provides a means of modulating the optical properties. For example, a dramatic enhancement in the emission quantum yield to >60% is observed due to exciton localization at isolated nanodomains of a conjugated polyelectrolyte entrapped within the ureasil host.^[5] Similarly, Förster resonance energy transfer from the ureasil to embedded or grafted conjugated lumophores can be exploited to tune the emission color^[6,7] and even obtain white-light emission.^[8] These characteristics can be exploited to improve light-harvesting and trapping within the integrated material, which can be used to develop highly efficient spectral converters to enhance the performance of solar cells.^[9]

References

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Biography



Dr Rachel Evans obtained her MChem (2002) and PhD in Physical Chemistry (2007) from Swansea University. She undertook postdoctoral research at the Université Paris-Sud, France and the University of Coimbra, Portugal. Between 2009-2016, Rachel was an Assistant Professor, then Associate Professor in the School of Chemistry at Trinity College Dublin. She then moved back to the UK to take up a Lectureship at the University of Cambridge, where she is also a Fellow of Jesus College. Rachel's research is focused on the design of photoresponsive soft materials for luminescent solar devices, stimuli-responsive systems and organic photovoltaics. She was recently awarded the Dillwyn Medal for STEMM from the Learned Society of Wales and the Macro Group UK Young Researcher's Medal. In 2018 she was awarded an ERC Consolidator grant to work on spectral conversion materials. In her free time, Rachel is a keen surfer and stand-up paddleboarder and enjoys attempting to grow vegetables.

Location

Bedson Building, 2nd floor, Lecture Theatre 2.76

Building 20 on the attached map:

<https://www.ncl.ac.uk/media/wwwnclacuk/whoweare/files/campus-map.PDF>

