

How Can We Design Integrated Spectral Conversion Materials to Power Smart Sustainable Cities?

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Light is ubiquitous in the urban environment – from the sun that shines down upon us to the artificial sources that light-up our devices and homes. While some of this light is used very effectively, for example by plants in the process of photosynthesis, much of it is wasted, either due to inefficient harvesting or poor recycling of the broad spectrum of wavelengths available. Spectral conversion materials provide a potential solution to this problem, using a photoluminescence process to convert available photons into energies that can be used more effectively. If such materials are integrated within a suitable host, they may provide additional features such as concentration of diffuse light, improved mechanical properties and the potential to retrofit to existing device installations. This opens up exciting opportunities to use light to power our cities, from functional architecture to data transfer.

In this talk, recent highlights from our research into the bottom-up design of integrated lumophore-host systems as spectral conversion materials will be presented. It will be shown that materials chemistry design strategies can be used to control the packing, orientation and placement of lumophores in solid-state polymeric and organic-inorganic hybrid hosts, which provides a means of modulating the optical properties – from enhanced photoluminescence quantum yields, to tunable emission colour via Förster resonance energy transfer. 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 for luminescent solar concentrators or as optical amplifiers for visible light communications. New results on the use of 3D printing to design the host architecture will also be presented.

Rachel grew up in South Wales. Following undergraduate (MChem) and graduate studies (PhD) in Swansea University, she undertook a short postdoctoral fellowship in the Marie Curie Training network CIPSNAC, spending time in the University of Coimbra, Portugal (Prof. Maria Miguel) and the Université Paris-Sud, France (Prof. Françoise Livolant). She returned to Portugal in 2008 with an independent FCT postdoctoral fellowship jointly between the University of Coimbra and University of Aveiro. In 2009 she cut this fellowship short to take up a contract lectureship at Trinity College Dublin, Ireland. She was appointed the Ussher Assistant Professor of Device Fabrication in 2011, elected to Fellowship in 2015 and promoted to Associate Professor in 2016. She moved to the University of Cambridge as a Lecturer in 2017, and was promoted to Reader in Materials Chemistry in 2019. Rachel is also a Fellow and Director of Studies (Materials) at Jesus College, Cambridge.

