SEMI-TRANSPARENT ORGANIC SOLAR CELLS FOR ENERGY GENERATING WINDOWS

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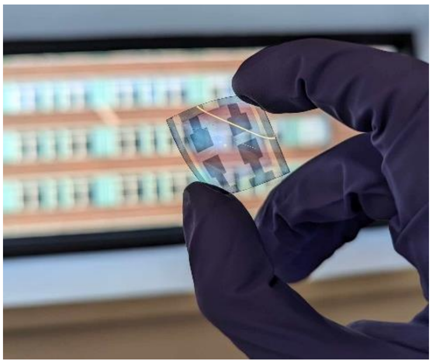

The urgent threat of global warmings demands diverse, rapid, and widespread adoption of renewable energy sources. Solar energy is the most abundant of these but is limited by the deployment challenges of traditional silicon-based panels; due to their heavy, brittle and opaque nature. A promising alternative is organic solar cells (OSCs). OSCs use solution-processable, carbon-based materials and can be manufactured at significantly lower temperatures than silicon. These features allow the use of flexible substrates, the possibility for cost-effective roll-to-roll printing, and yield a significantly lower manufacturing carbon footprint, all allowing deployment in niche applications that silicon cannot occupy.

The most exciting of these is in energy generating windows. Chemical modification of the light absorbing ('active') materials in an OSC can tune their absorption to outside of the visible spectrum, yielding 'semi-transparent' solar cells. Installation of flexible, semi-transparent OSC films as energy generating windows could dramatically increase the available surface area for solar energy capture in new or existing buildings- advancing net-zero architecture targets, and allowing localised energy generation, reducing grid dependence and supporting emerging internet of things (IoT) applications. However, there are still several significant challenges facing the widespread commercialisation of semi-transparent OSCs, including using industrially appropriate materials, scalable fabrication, and losses in performance upon increasing area.

In this poster, I will present the advancement and optimisation of a scalable semi-transparent OSC, working towards real-word, commercial viability. Each nanometre scale layer has been tuned through device-based screening to yield high performance, semi-transparency, low toxicity, and cost-effectiveness. Active materials absorbing mostly in the infrared region have been used to ensure good visible transmission. Scale-up has built upon this work, through increases in cell area and series connections to form solar modules. Traditional spin coating has been replaced by lower-waste, industry suitable blade coating, and evaporated silver has been replaced by silver nanowires to yield a truly printable, scalable, semi-transparent device, that has been demonstrated in small scale IoT applications.

This work is part of a wider Innovate UK funded project with Manchester based window-film company Contra Vision, and builds upon my previous publications focusing on the morphology and scale-up of OSCs.[1–3] The results shown here bridge the gap between laboratory-scale and industrial-scale production of OSCs, providing valuable insights for the manufacturing process and culminating in the fabrication of a functional, scalable, semi-transparent prototype for use in energy-generating windows.

References

[1] E. L. K. Spooner *et al. ACS Appl. Mater. Interfaces* **2023**, *15*, 39625.
[2] R. C. Kilbride *et al. Small* **2024**, *20*, 2311109.
[3] R. C. Kilbride & E. L. K. Spooner *et al. ACS Appl. Energy Mater.* **2024**, *7*, 8401.