Semi-transparent Organic Solar Cells for Energy Generating Windows

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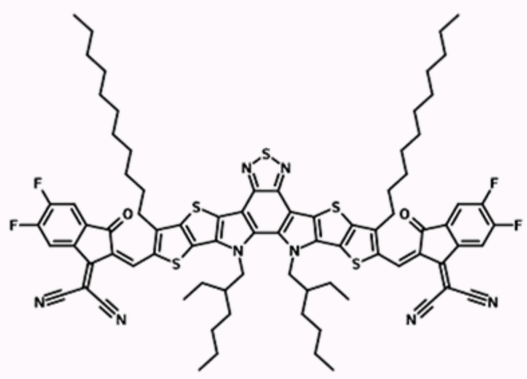
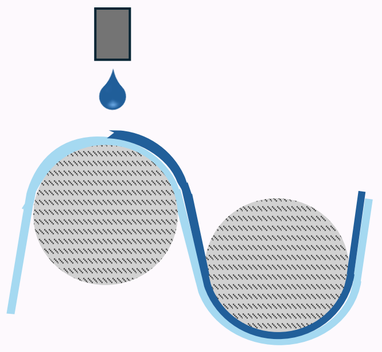
What is the Problem?

- Increasing the use of solar energy is vitally important in our fight against climate change
- Traditional rooftop solar panels are made out of silicon, but this is brittle, heavy & opaque- so can only be installed in limited locations
- It also requires a lot of energy to manufacture because of the high temperatures involved
- **These factors restrict solar adoption**

What are Organic Solar Cells?

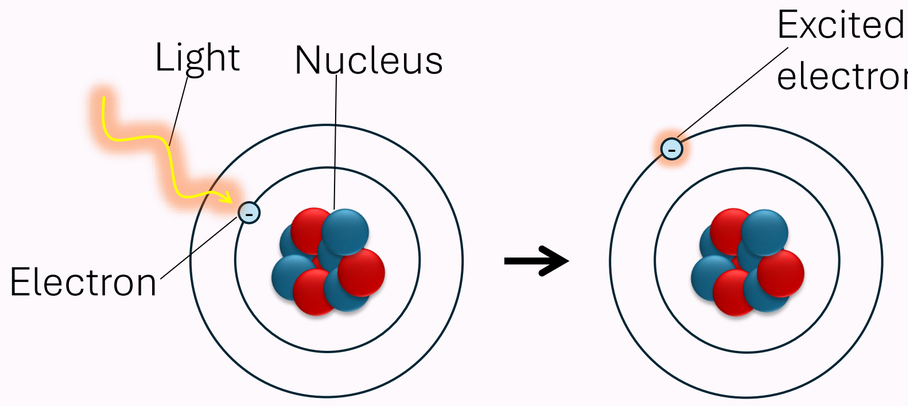
- Organic solar cells (OSCs) are an alternative technology to traditional silicon solar panels
- They use 'organic materials'- which are based mostly on carbon (like polymers) and can easily be dissolved in solvents
- This means OSCs can be fabricated at low temperatures via roll-to-roll printing- allowing the use of flexible substrates, fast & cheap manufacture and a low carbon footprint





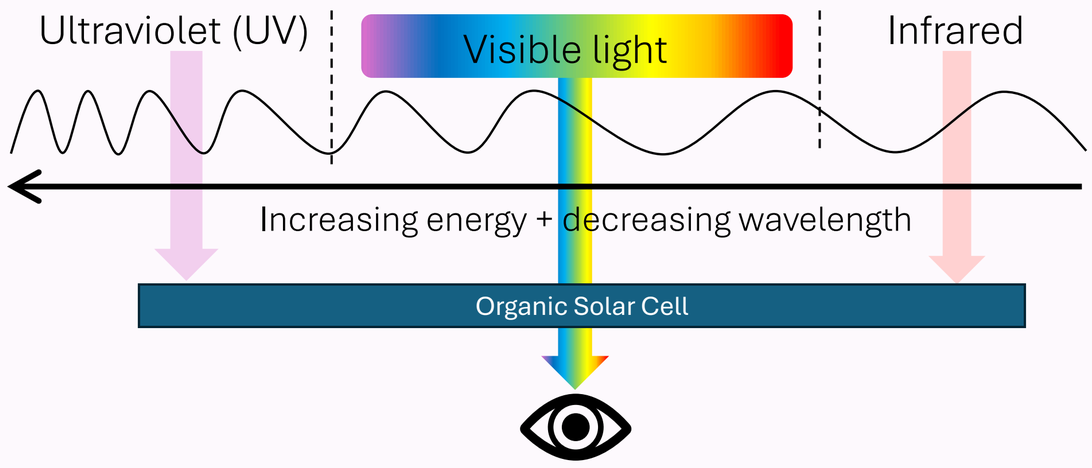
How do they Work?

- Like other solar technologies- in OSCs, an active material absorbs light from the sun, which arrives in packets of energy called photons
- The electrons in the material are 'excited' to a higher energy level, which makes them easier to pull out to form a current



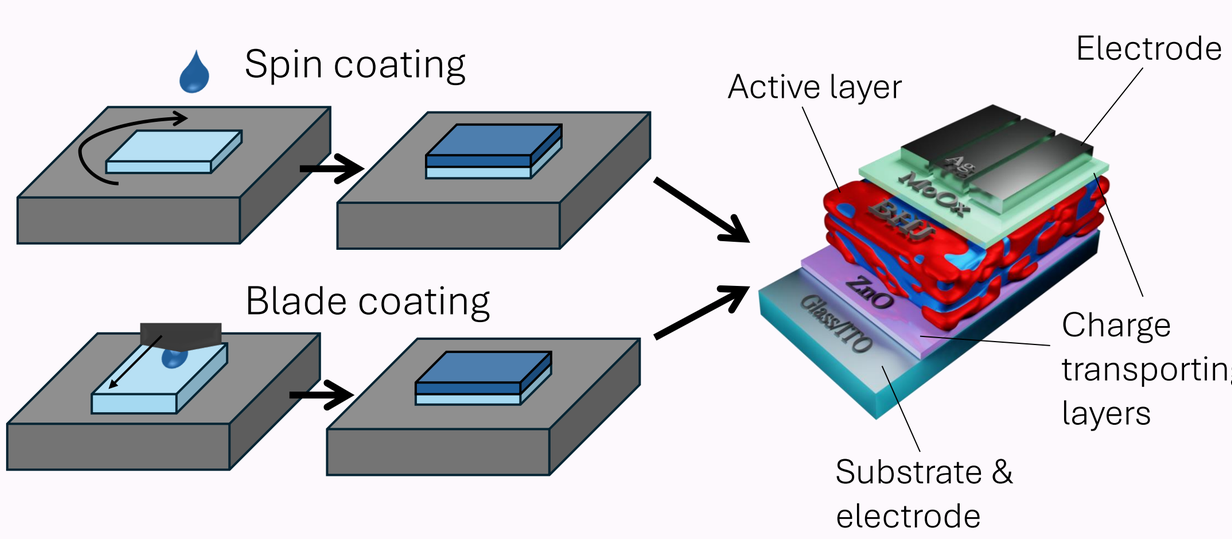
How Can We Make Them Transparent?

- Radiation from the sun varies in its wavelength & energy
- By carefully designing the molecular structure of OSC materials we can control which wavelengths of light are absorbed
- This means we can let through visible light, but absorb ultraviolet or infrared light (IR) to create energy- allowing us to create mostly transparent solar windows



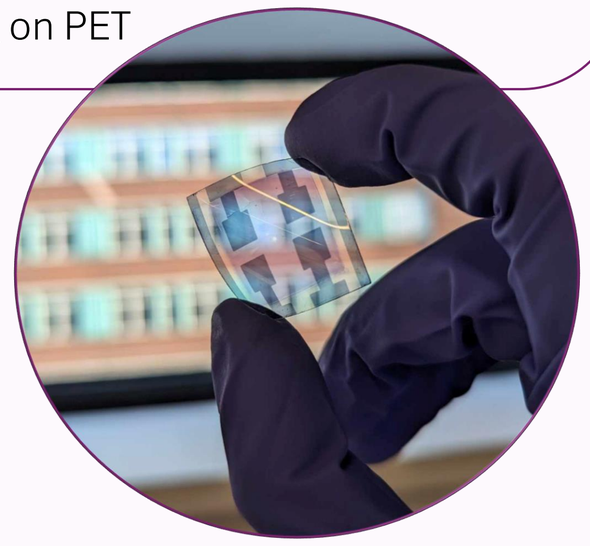
Experimental Methods

- My project is part-funded by a company hoping to commercialise OSCs- so I focus on industrially relevant fabrication
- OSCs are usually manufactured via spin coating several consecutive layers (dropping solution onto a spinning piece of glass). Each layer performs a different function.
- We've focused on spin coating alternatives that can be easily scaled up (like blade coating), and choosing cheap & non-toxic materials to create semi-transparent devices



Key Achievements

- Using IR absorbing materials we have achieved visible transparencies approaching 50%
- Through intentional device design & material choice we have scaled up our absorbing area 50x without loss of performance.
- Via blade coating optimisation we've reached equivalent efficiencies to control, spin coated devices
- By choosing low temperatures processes we have fabricated flexible devices on PET



Impact

Flexible, transparent OSCs can widen the available opportunities for solar deployment- advancing net zero architecture & allowing localised energy generation. This could reduce grid dependence & facilitate new internet of things applications.

1. Y. Li et al., Semitransparent Organic Photovoltaics for Building-Integrated Photovoltaic Applications, *Nat. Rev. Mat.* **8**, 186-201 (2023).
2. M. Riede et al., Organic Solar Cells- The Path to Commercial Success, *Adv. Ener. Mater.* **11**, 2002653 (2021).