# Investigating Hole Transport for Higher Efficiency Solar Cells

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## Motivation and Aims ①

Cheap and efficient solar cells are vital to reaching net zero carbon emissions. In this area, perovskite solar cells are a promising technology and understanding how a type of charge called a hole moves through the material is important to improving their efficiency.

**Main Aims:**

- Design and make equipment to measure the mobility of holes in organic semiconductor films.
- Test the equipment and verify the obtained values against ones obtained using established methods and those in literature.

## Background ②

- A perovskite is a material with a specific crystal structure.
- A perovskite solar cell is made up of layers of material, each layer with a different role. One of these layers is made from a perovskite material.

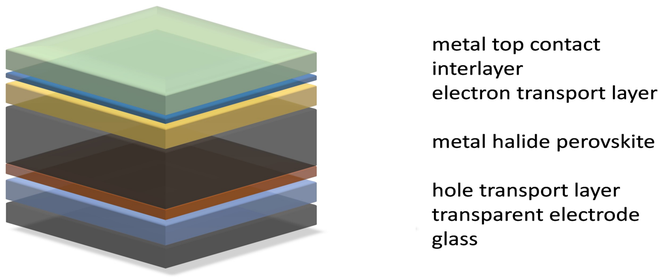
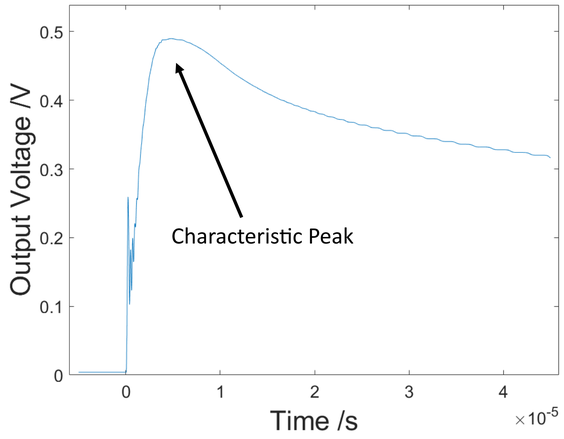



Fig 1

- The role of the perovskite layer is to generate charge when light hits the material.
- Another layer, called the hole-transporting layer, moves holes away from the perovskite layer once they are generated.
- The faster the holes move in this layer the more efficient the solar cell is.
- The speed the holes move at is described by the hole mobility, the higher the mobility the faster the holes move and the more efficient the solar cell is.

## Current Transient Measurements ③

- Measuring the hole mobility is an important aspect of developing better hole transporting layers, and hence more efficient solar cells.
- The type of materials measured produce a curve with a distinct shape when a jump in voltage is applied across it. This curve is called a current transient, shown below.




- The mobility can be calculated from the amount of time it takes the characteristic peak to appear.
- The smaller the time it takes the peak to appear, the higher the mobility of the material.
- Current transient measurements work well over a wide range of layer thicknesses and do not require curve fitting to extract values, making them a practical and accurate type of measurement [1].

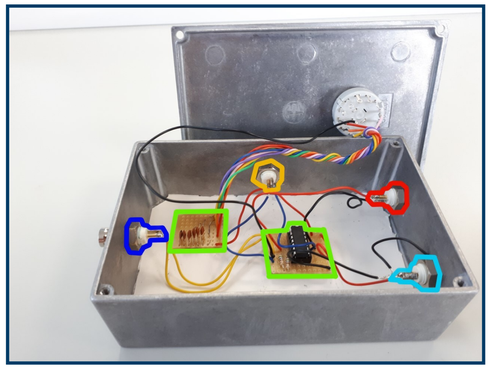
## Outcomes ④

**Main Outcomes:**

- Built equipment to obtain current transients in hole transporting layers.
- Extracted values of hole mobility from these transients.
- Confirmed the extracted values made sense when compared to ones obtained using established methods or those in literature.

**The Equipment:**

- **Connection** to oscilloscope, the device used to display and acquire the current transients.
- **Connection** to pulse generator, which creates the voltage jumps.
- **Connection** to sample holder, allowing samples of different materials to be swapped easily.
- **Connection** to power source for microchip.
- **Circuitry** used to remove unwanted parts of current transient.



## Acknowledgments and References ⑤

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Fig 1 - https://www.m2ngroup.nl/research/research_programs/perovskite-solar-cells/

[1] - Journal of Applied Physics 93, 341 (2003); https://doi.org/10.1063/1.1525866