SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Specialised Stability Testing of Perovskite Solar Cells

Every day, we receive enough energy from the sun to power our planet for over 27 years. Solar energy is therefore regarded as the cleanest and most reliable energy resource, offering unlimited potential in decarbonising our future energy supply and addressing key societal challenges such as global energy shortage and climate change. Over the past decades, silicon-based photovoltaics, a technology that directly converts sunlight into electricity, have been the most dominant technology for solar energy conversion (e.g. rooftop solar panels). However, silicon-based photovoltaics are typically bulky and rigid, with high manufacturing and installation costs.

Recently, there has been rapid progress in the development of next generation solar cells based on solution processed semiconductors, including in particular perovskite, organic and quantum dot solar cells. This technology differs from conventional photovoltaics in that it is typically lightweight, flexible, versatile and in-expensive, making them not only a low cost alternative to conventional photovoltaic applications (e.g. power stations, rooftops, off-grid charging) producing electricity with significantly reduced cost, but also promising for new target applications (e.g. Internet of Things, battery-free electronics, energy-positive buildings, power generating windows).

However, the typically limited operating stability and short operating lifetime has now been widely recognised as a common bottleneck for the commercialisation of next generation solar cells, with exposure to various environmental factors known to cause rapid losses of their performance, the origin of which often remains unclear.

This PhD project aims to address the stability challenge of perovskite solar cells by studying their degradation mechanisms under three unconventional operating conditions, namely low light, reverse bias and mechanical strain. Unravelling the degradation mechanisms and improving solar cell stability under these conditions will unlock the application of perovskite solar cells for emerging applications including indoor sensing/energy harvesting, elastic/stretchable solar cells and solar modules robust to partially shaded conditions.

2. Project Scope

The research project objectives are
1) to identify the key environmental stress factor(s) driving the degradation of perovskite solar cells under low light;
2) to establish the degradation behaviour of perovskite solar cells under reverse bias conditions, and
3) to determine how the degradation of perovskite solar cells is influenced by an external mechanical strain.

3. Desired Skills from the Student

The project requires the following knowledge and experimental skills:
At least a basic level of knowledge of semiconductors, solar cells or electronics (Essential)
Experience and skills in wet chemistry materials processing and characterisation of thin films (Desired)
Experience and skills in solar cell fabrication and efficiency measurement (Desired)
Experience and skills in solar cell stability testing protocols and measurements (Desired)

4. Supervisory Team

Primary: Dr Zhe Li