SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Stability and Degradation of Organic Solar Cells Fabricated via Aerosol-Assisted Chemical Vapour Deposition

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. This PhD project is designed to investigate the stability and degradation mechanism of organic solar cells fabricated via Aerosol-Assisted Chemical Vapour Deposition (AACVD), a highly promising and fully industrial compatible technique recently developed by SEMS researchers. This technique has the potential to combine the advantages of both the established small scale (e.g. spin coating, typically good homogeneity but poor compatibility with industrial manufacture) and large scale processing techniques (e.g. slot-dye coating, unscalable but typically has poor film homogeneity), thereby creating a unique opportunity and manufacturing route for the commercialisation of organic solar cells.

2. Project Scope

The objectives of this project include:

1) to test the stability of high performance organic solar cells fabricated using AACVD method under various environmental conditions in comparison to standard solar cells fabricated using spin coating method;
2) to apply a range of advanced characterization techniques to understand the degradation mechanisms of solar cells fabricated using AACVD method;
3) to use the knowledge to develop new materials and device structures and processing routes to substantially enhance the stability of organic solar cells fabricated using AACVD method

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