SEMS: RESEARCH PROJECT DESCRIPTION

1. Project Background and Description

Eco-Toxicity Analysis 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).

In contrast to these developments, the potential impact of this PV technology upon the environment remains poorly understood, especially considering that many of these solar cells are fabricated using toxic solvents (e.g. chloroform, DMF) and contain environmentally harmful elements (e.g. lead). This PhD project aims to quantitatively understand the potential environmental impact of the future commercialisation of perovskite solar cells by identifying and quantifying the release pathways of various harmful elements (e.g. Pb, Cs) from benchmark lab-scale devices into the surrounding environment (e.g. water, soil), as well as developing new materials and device designs to mitigate these impacts.

2. Project Scope

The objectives of this project include:
1) the chemical leaching tests of harmful materials from the benchmark perovskite samples and the evaluation of their environmental impacts;
2) the quantitative investigation of how the release of harmful materials from the perovskite samples is determined by their materials and device design, and
3) the development of novel low eco-toxicity perovskite solar cells without compromising their power conversion efficiency.

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