Worshipful Company of Scientific Instrument Makers

Apprentice Annual Report – Oliver Bridge

This report outlines my activities and progress over the past year as an apprentice of the Worshipful Company of Scientific Instrument Makers. It covers the completion of my undergraduate degree, my time in Sydney and the start of my postgraduate degree at Imperial College London. I hope you enjoy!

This year marked the completion of my undergraduate degree at The Engineering and Design Institute London, where I achieved a First Class Honours, graduating as the second ever cohort. I started the year basking in the glorious Sydney sun, where I lived for six months, completing my Individual Research project at the University of New South Wales (UNSW) as part of the Research Practicum Exchange Programme. I was based at the School of Photovoltaics and Renewable Energy Engineering, working on my thesis titled "**Design and Initial Evaluation of a Vacuum Thermal Cycling System for Low Earth Orbit Si Solar Cell Interconnect Testing.**" The aim was to investigate low-cost alternatives to conventional thermal-vacuum cycling (TVAC) systems, which remain inaccessible to many CubeSat developers due to their high cost and complexity.

I designed a modular thermal cycling platform using thermoelectric (Peltier) devices within a vacuum chamber, built a stacked Peltier assembly to drive the temperature extremes, and evaluated two common solder alloys (Sn60Pb40 and In52Sn48) using electrical (I–V), optical (photoluminescence), and microstructural (Scanning Electron Microscopy with Energy Dispersive Spectroscopy) techniques. Although time limitations prevented full thermal cycling, the system successfully demonstrated the feasibility of early-stage qualification testing for nanosatellite interconnects, and the work produced several recommendations for future improvement of the rig.

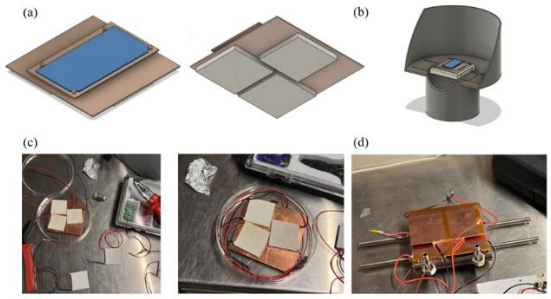

Figure 9. (a) CAD models of thermoelectric stack and, (b) stack inside the chamber (c) Wiring of Peltier devices in series. (d) Full assembly of thermoelectric stack.

Figure 1 Experimental setup / Peltier stack

Being part of a research group and working daily with PhD students and academics expanded my understanding of semiconductor physics and photovoltaic technology and reinforced how much I enjoy experimental research.

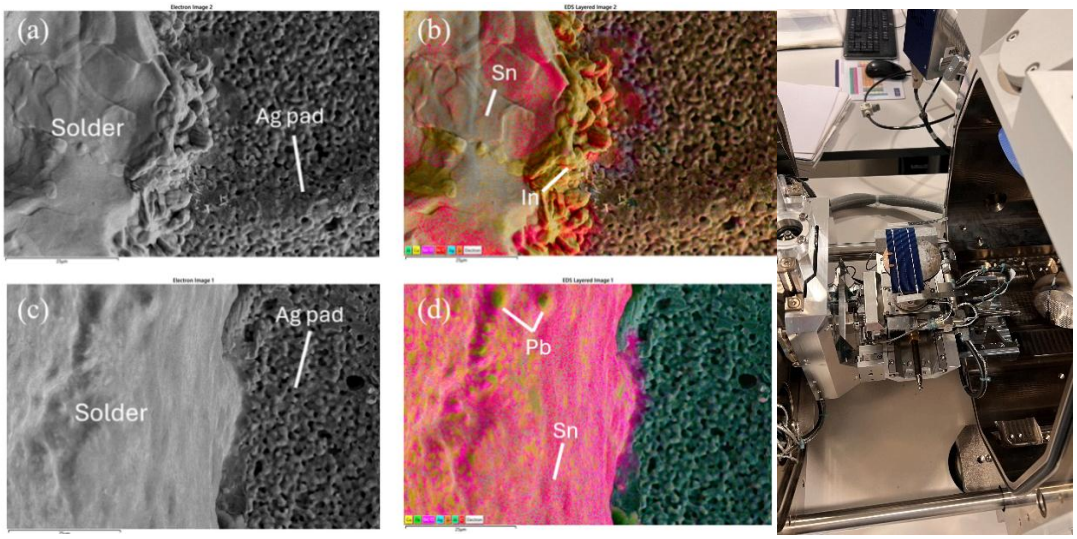

Figure 2 (Left) SEM images and EDS maps of (a-b) In52Sn48 and (c-d) Sn60Pb40 joints. (Right) Nova Nano SEM 450 holding solar cell sample.

Alongside my academic work, my time in Sydney was one of the most enjoyable experiences of my life. I lived in Paddington with two close friends, and outside the lab we made the most of the Australian lifestyle life: barbecues, beach trips, surfing, and exploring the city and national parks. We were able to walk to these amazing places like the Opera House, Harbour Bridge and so many other beautiful places around Sydney. We also learned to scuba dive (on my 21st birthday!), travelled to hike around the Blue Mountains and other national parks frequently - only seeing a handful of snakes and spiders! My brother and Girlfriend also visited, showing them around, experiencing such a different place and exploring more of the region together was a lot of fun.

These experiences not only made my time abroad memorable but also contributed to my personal development and independence. Sydney remains a place I miss greatly, and the time spent there will have a lasting impact on me!

Figure 3 Sydney photos (Harbour Bridge, scuba diving and Ku-Ring-Gai national park)

Due to spending the first half of the year in Australia, I was unfortunately unable to attend as many Company events as I would have liked. However, since returning to London I have been excited to re-engage with the Livery. I attended the Admissions Court Dinner, where I saw my Apprentice Master, Jane Fishwick, installed as the first ever Master of the company, and I also had the opportunity to take part in the Lady Mayor's Show; an experience that was both memorable and a pleasure to be a part of! I remain very grateful for the support and encouragement provided by members of the Company, and I look forward to being more involved in the coming year.

Figure 4 WCSIM group for the Lady Mayors show

Motivated by the research experience I gained at UNSW, I applied for and was accepted onto the Master's of Research in Engineering Design programme at Imperial College London, based at the Dyson School of Design Engineering which I began this autumn.

My current research project focuses on the recycling and recovery of precious metals from end-of-life photovoltaic panels, an increasingly urgent challenge as renewable energy infrastructure scales globally and many panels are reaching the end of their 20-30 year lifetimes. Solar modules contain valuable materials such as copper, silver, and gold, but these are difficult to extract due to the surrounding glass, polymers, and other metals.

The project explores bioleaching - using bacteria, fungi, or plant systems to recover metals with minimal pre-separation. I am working to design a workflow to enable selective and sequential extraction of copper and silver, identifying appropriate biological strains, reviewing the current state of bio-extraction technologies, and conducting

experimental trials in the chemistry lab. The project is supported by Fraunhofer (who supplied the PV shred below), Rio Tinto, and my supervisor Dr Elena Dieckmann, offering both industrial and academic insight into sustainable materials processing.

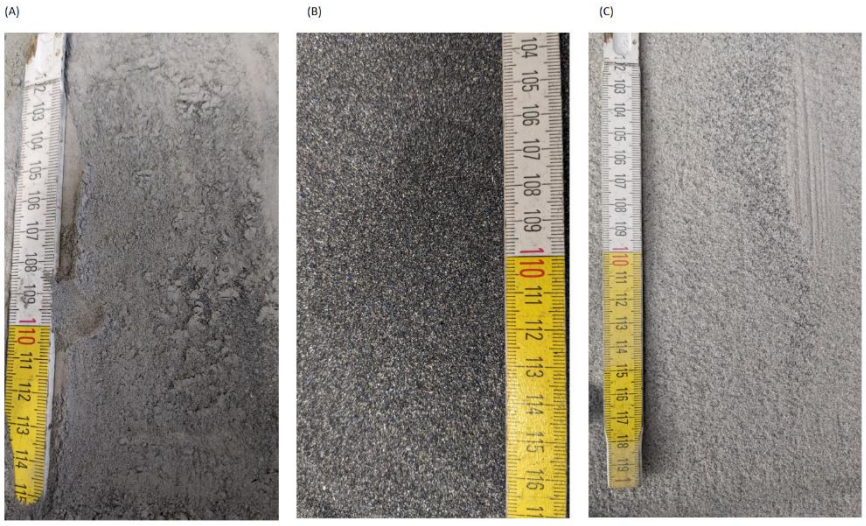

Figure 5 Black mass PV shred material, provided by Fraunhofer containing varying amounts of Si, Cu (0.9 %), Ag (2.6 %), Pb (0.3 %), Sn (0.6 %), Al etc.

This work has already deepened my interest in research, and I am very excited about the months ahead!

Looking forward, I aim to complete my MRes research project and develop my practical laboratory skills further. I hope to continue engaging with WCSIM throughout the year and to seek opportunities to present or discuss my work with members of the Company. My long-term ambition is to pursue a research-focused career in renewable energy technologies, materials, or software-electrical engineering, building on the experiences of the past twelve months.