ARENA Insights Spotlight: Meet the Researcher

SEPTEMBER 2019

Australian Government
Australian Renewable Energy Agency

ARENA

INTRODUCTION

Australia's best and brightest solar photovoltaic researchers are making ground-breaking discoveries through their ARENA-funded research and development projects. In this spotlight piece, we have captured highlights, challenges and opportunities these researchers have come across in their projects and careers, which we hope will inspire our readers.

DOCTOR BRETT HALLAM

Dr. Brett Hallam is a Scientia Fellow in the School of Photovoltaic and Renewable Energy Engineering at UNSW. His research interests include laser processing and defect-engineering for silicon solar cells. He is involved in the following ARENA funded projects: "Hydrogenated and Hybrid Heterojunction p-type Silicon PV Cells RD Project"(Lead), "World-Record Commercial High-Efficiency n-type Solar PV Cells through Recombination Analysis and Innovative Passivation", "Hydrogenated Bifacial PERL Silicon Solar PV Cells With Laser Doping and Plated Contacts" and "Development and Commercialisation of High-Efficiency Silicon Solar Cell Technologies".

ARENA: Please describe your ARENA-funded project briefly?

BH: My primary ARENA funded project is about taking cheap, p-type silicon wafers and figuring out how we can improve the quality of the material enough to make ultra-high efficiency heterojunction solar cells responsible for world record solar cell efficiencies, which usually require expensive, high-quality n-type wafers.

ARENA: Why is this project important?

BH: This project is about demonstrating the potential of p-type silicon solar cells for the future solar cell technologies. There is a widespread belief that p-type wafers will not be good enough for upcoming high-efficiency solar cell technologies. However, the majority of solar cells at the moment are made on p-type wafers, which are significantly cheaper than n-type wafers. If we can show that the p-type wafers today are in fact compatible with ultra-high efficiency technologies, it will give us another pathway to high-efficiency, low cost solar cells, without the need for such a drastic shift in processing from what is done today.

ARENA: What are your biggest achievements in this project so far?

BH: The biggest achievement in the project so far has been fabricating a finished heterojunction solar cell with an open circuit voltage of 738 mV using standard p-type crystalline silicon material. This is a significant boost compared to state-of-the-art PERC cell technology sitting around 680 mV to 690 mV in production with efficiencies approaching 23 per cent. This means that we could be looking towards 25 per cent in the future for solar cells made on these same wafers.

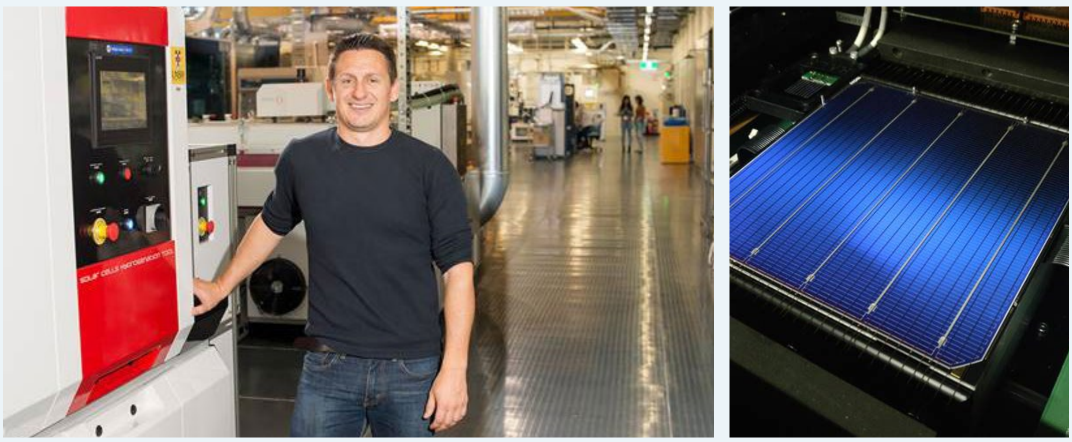

Figure. 1: In the left image Dr. Brett is beside an industrial advanced hydrogenation tool. The right image is of a new IV (current-voltage) testing tool that can measure the efficiency of heterojunction solar cells (manufactured by Meyer Burger) without busbars.

ARENA: What are the other competing technologies and what differentiates your work from them?

BH: Most efforts around the world for next-generation solar cells jump towards using n-type wafers and rely on a high incoming wafer quality. We are using the approach of taking a wafer, whether that is good or bad, and then looking for ways to improve the quality of that material as we make the solar cell structure. For the high-quality material, this means we could be looking at pushing efficiency limits further. This is already looking interesting for reasonably high-quality n-type wafers. For the low-quality material, we can bring that to a quality required for the high-efficiency device structures.

ARENA: How are you trying to commercialise your research outcomes?

BH: We are working with the leading crystalline silicon producer LONGi Solar and an equipment company Meyer Burger, who can supply turnkey production lines to manufacture heterojunction solar cells. The 738 mV device was fabricated as a full large area device using Meyer Burgers industrial equipment. We have also been working with a few different heterojunction solar cell companies to work towards transferring the newly developed processes into production, including what we have been able to transfer over to current industrial n-type heterojunction solar cells.

ARENA: What are the biggest challenges and opportunities for photovoltaic R&D projects going forward? What are you doing to address those challenges?

BH: One of the biggest challenges is how to accelerate the deployment of photovoltaics. A barrier for people to install solar is still the upfront cost, even though the system could pay itself off in a few years, and then be saving money. If solar becomes cheap enough, consumers can help drive the transition towards clean energy.

A keyway where R&D can help to accelerate deployment of photovoltaics is to increase the efficiency. Doing so can save on installation costs, as we can get more power out of each solar panel, so we don't need to install as many. Material cost savings along the way will also help to reduce the overall cost as long as the efficiency isn't compromised. My research is addressing both of these avenues. But reducing the cost of solar isn't just important for electricity generation, it is also other sectors such as transportation. It is now looking interesting where it could be cheaper to use photovoltaics to charge a plug-in hybrid for commuting to work each day, than using petrol or diesel.

ARENA: How do you see yourself? Engineer, Chemist, Physicist?

BH: I see myself as more of an engineer, but at times the work does get relatively deep into the physics/chemistry of what is happening inside the solar cell. Where possible I like to understand what is going on, but more importantly, I like to take that understanding and use that to my advantage to help find solutions to problems in solar.

ARENA: How many students or staff are in your team?

BH: For my heterojunction project there are 12 people involved at UNSW between senior and postdoctoral researchers, postgraduate students and undergraduate research assistants. However, this is also a close collaborative project with Prof. Zachary Holman's team at the Arizona State University (USA) and Prof. Daniel Macdonald's team at the Australian National University.

ARENA: Can you tell us about your journey to get to this position? Where/what did you study? How did you become a researcher?

BH: Well I wouldn't exactly say it was planned; it was more of an accident. I wasn't even thinking of going to uni until the end of year 11. But when I was flicking through the university's course guide, I found a course on photovoltaic engineering at UNSW that sounded interesting and I studied that. During the first year of uni I started working as a researcher in the lab, and it kind of just went from there. I really enjoyed being in the lab, much more than in the classroom. After I finished my undergrad, I continued with a PhD in photovoltaic engineering at UNSW as that seemed like the logical thing to do to get more involved with research. So, I haven't travelled too far. But during my PhD, I spent a year in Belgium doing research.

ARENA: What are the qualities which a researcher should possess or what are your tips to aspiring researchers?

BH: The ability to think outside the box is a key quality for a researcher, and not just assuming what is published is correct. Two people can look at the same problem and come up with two completely separate solutions, both of which might be correct. Research is about coming up with ideas or theories and working out which of those are useful or correct, and which of those are not.

With that in mind, it is important to understand that a negative result is also a good result and that knowledge should be shared. It might not be the answer you are after, but sharing the knowledge can stop others spending time to reach the same conclusion. In other instances, a negative result might help point you in the right direction to find the answer.

I also think you need to have a passion for what you are researching. There can be a lot of work involved and a lot of ups and downs and frustrations along the way to get a positive result. Having something to switch off the mind is essential, too.