ARENA Insights Spotlight: Meet the Researcher

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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.

PROFESSOR KYLIE CATCHPOLE

Prof. Kylie Catchpole is from the Research School of Engineering at the Australian National University (ANU). Her research interests include novel materials for photovoltaics and solar fuels. She is leading the following ARENA funded projects - "Monolithic perovskite – silicon tandem cells: towards commercial reality"; "Development of stable electrodes for perovskite solar cells" and "Low-Cost Perovskite/Silicon Semiconductors Integrated with Earth Abundant Catalysts for Efficient Solar Hydrogen Generation."

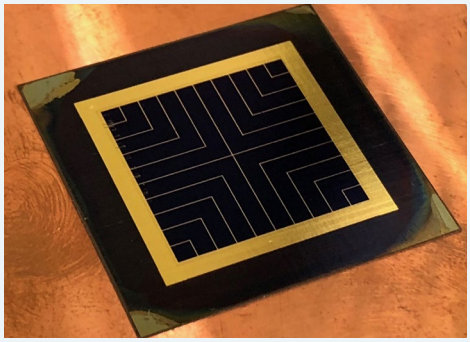

Figure. 1: A 4 square centimetre monolithic perovskite-silicon tandem solar cell fabricated at ANU (Y. Wu, ANU).

ARENA: Please tell us about your ARENA-funded projects.

KC: We are currently working on a number of ARENA projects, which are all aiming to solve some high priority challenges, but I'll tell you about our work on tandem solar cells because our other projects are still in the early stages.

The project is called "Monolithic perovskite-silicon tandem cells: towards commercial reality". In this project we are working with Jinko Solar to improve the efficiency and stability of solar cells that are based on a combination of perovskite and silicon material.

The advantage of combining two materials is that one can absorb the blue light in the solar spectrum, and the other can absorb the red light. This gives a higher efficiency than just using one material. In this project, in particular, we are looking for fabrication processes of perovskite cells that lead to high efficiency but are also compatible with commercial silicon solar cells.

ARENA: Why is this project important?

KC: Presently, the majority of the cost of solar electricity does not come from the solar cell, but from the other 'balance of systems' costs, such as installation, glass and wiring. In order to reduce these costs, we need to use less materials while also optimising the efficiency of the solar modules, which means the solar modules that can produce more power for a given area.

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

KC: So far, we have been able to achieve excellent solar cell performance using processes that are relevant to the industry in fabricating solar cells. We have improved the technique that we used to deposit the perovskite material, and we have replaced one of the expensive layers in the perovskite cell with a much cheaper and more stable alternative.

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

KC: There are other research teams around the world working on integrating perovskite and silicon solar cells, with a range of approaches. The advantage of our approach is that we are combining the dominant silicon fabrication technology with solution-processed perovskite. Solution-processing is potentially cheaper and has also demonstrated the highest efficiencies so far for perovskite cells. We think this approach has the potential to achieve very high efficiencies at low cost.

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

KC: We work on a range of projects at different technology readiness levels. For the projects at the earlier levels we aim to develop the technology and demonstrate its potential. These projects are essential, because you can't commercialise anything without developing new ideas. For projects at later stages of development such as this one, we work with companies such as Jinko Solar, to ensure our work is aligned with commercial requirements.

ARENA: What are the biggest challenges and opportunities for photovoltaics R&D projects going forward?

KC: Photovoltaics is now a commercialised technology. That means that there are greater opportunities for building on the current technology. This is why we feel that tandems are such a promising direction — they build on the key achievements of silicon technology, while offering the possibility of getting to much higher efficiencies that silicon could achieve on its own.

The challenge is to achieve this at low cost. This means that we need to be very clear about what materials can and cannot be used in future technologies. This is actually the focus of one of our other ARENA funded projects, which is stable low-cost contacts for perovskite solar cells.

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

KC: I try not to define myself too narrowly. I have an undergraduate degree in physics, a PhD in engineering, and am now publishing much of my work in physical chemistry journals. The key thing is to be constantly learning, and to work within an ecosystem of people with different skills, so that the whole is greater than the sum of the parts.

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

KC: I collaborate closely with A/Prof. Klaus Weber and A/Prof. Tom White at ANU. Together we supervise a group of about 15 people working on perovskites and perovskite silicon tandems. We also collaborate very closely with the silicon solar cell group at ANU. The ability to have a sufficiently large group of people in order to create synergies is crucial in research.

ARENA: Can you tell us about how you got to be here?

KC: As I mentioned I have an undergraduate degree in physics. At the time I was not sure what I wanted to do with that. I thought maybe studying particle physics – I was very curious about the origins of the universe. At the same time, I wanted to do something to help the environment, but I didn't have an idea of how I could use my interests and skills to do that. Then I discovered solar cell research. It was a perfect fit of my analytical bent and curiosity to a research field that could really make a difference to the world.

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

KC: I would say number one is persistence! Ninety nine times out of 100 what you are trying will not work for one reason after another. You have to keep going, and figure out what you can do differently so that your experiment has no choice but to work! In order to do this, it helps to be optimistic. I was always sure my next experiment was going to work, even though the previous 98 hadn't. In addition to this it helps to be adaptable and to be always learning.

I would always recommend that researchers be strategic. Make sure you are solving big problems, and think about you can work together with other people to do this. Don't just get bogged down in a problem without first asking how important it is and if it is important, how other people could help.

Finally, I would say that curiosity is essential. If you follow curiosity you have the possibility of creating new things that had not previously even been imagined.