



How to use hydrogen passivation to fix defects in silicon

Project Name: [Overcoming the fundamental performance limitations of commercial solar cells](#)

Knowledge Category:	Technical
Knowledge Type:	Technology
Technology Type:	Solar PV
State/Territory:	New South Wales

Key learning

How to use hydrogen passivation to fix defects in silicon

The effectiveness of hydrogen atoms in fixing up virtually any crystallographic defects or losses in performance associated with the presence of unwanted contaminants in the silicon. Of particular importance has been the knowledge gained in relation to how to control the hydrogen in a way that makes it far more effective in carrying out its passivation capabilities. This work has been particularly novel, with important patents arising from the work.

Implications for future projects

This new hydrogenation technology should be relevant to any silicon-based solar cell technology as a way of reducing losses and improving cell efficiencies. In particular, it allows lower quality silicon wafers and still makes high efficiencies feasible. It should therefore be an integral part of any future projects or solar cell technologies that are using the low cost commercial grades of silicon such as the new ARENA RND068 project where it will be used for the new generation of Pluto solar cells.

The technology is Australian owned and so can be available to any Australian projects or Australian solar cell technologies and manufacturing.

Knowledge gap

Techniques for implementing the hydrogen control that allows far more effective passivation have been developed, but this needs to be extended to develop and demonstrate manufacturability and commercial implementation.

The hydrogen passivation needs to be developed and adapted and demonstrated for all silicon-based solar cell technologies world-wide

Additional work to improve our understanding of the fundamental physics behind the extraordinary results and processes achieved through hydrogen passivation would provide valuable insight that would assist in enabling this technology to reach its full potential.

Background

Objectives or project requirements

The project was aiming to improve the efficiencies of solar cells. An important part focused on minimising the losses associated with silicon wafers from which the solar cells were made. Through this, new techniques were developed for controlling the charge state of the hydrogen atoms that were diffused into the silicon, with the important benefits that this allowed improved mobility and reactivity for the hydrogen atoms. This in turn increased their ability to bond to any types of defects within the solar cell, therefore removing their negative impacts on cell performance.

Process undertaken

New insights into the mechanisms determining the charge state for hydrogen atoms were gained through extensive literature research covering the last three decades. This revealed the large benefits potentially achievable if the charge state of the hydrogen could be controlled, such as a million times improvement in the hydrogen's mobility within the silicon. The important breakthrough came when an innovative approach based on the use of high intensity light was developed that allowed the charge state for the hydrogen atoms to be controlled. The power of this was then easily demonstrated by having industry partners bring their own wafers which could be processed in a matter of seconds to immediately demonstrate massive improvements in wafer quality. Perhaps an even more compelling demonstration was through controlling the charge states for the hydrogen locally in one region, showing large improvements in the wafer quality in that region while the quality of the rest of the wafer remained poor.

Supporting information

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Hamer, P., Hallam, B., Wenham, S. and Abbott, M., "Manipulation of hydrogen charge states for passivation of p-type wafers in photovoltaics", IEEE Journal of Photovoltaics, Vol. 4, 201.

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