A simple technique using common materials could lead to significantly cheaper solar cells

October 19 2017

In the search for alternatives to silicon-based solar cells, A*STAR researchers are investigating a new material that is cheaper and easier to make, and could lead to better performing solar cells.

Silicon solar cells are highly efficient, converting up to 25 per cent of sunlight into electricity, but fabricating the silicon wafers, which need to be around 300 microns thick to absorb all the sunlight that falls on them, is an expensive process that requires temperatures of around 1,200 degrees Celsius.

A cheaper alternative to silicon is cadmium telluride; however, it is highly toxic and known to cause cancer. This spurred Goutam Dalapati and colleagues from the A*STAR Institute of Materials Research & Engineering to investigate a copper-zinc-tin-sulfide (CZTS) compound, which offers the optical and electrical properties required in solar cells, but is made from non-toxic, widely available materials that are cheaper than silicon to process.

"CZTS is a semiconducting compound with a higher absorption coefficient than silicon," says Dalapati, "so it's able to absorb more visible light and produce more electricity than silicon, and can be used for very large-scale applications, like roofs and solar farms."

Solar cells made from CZTS have potential for up to 30 per cent efficiency, but require high-quality, thin films of CZTS with no impurities, and a suitable material for the 'buffer' or interface layer that sits underneath the CZTS, helping to collect electrical charge.

A technique called quaternary sputtering was used to grow thin films of CZTS, where a single target made from CZTS was used as a source for depositing the film. This method offers several advantages over other deposition methods, including excellent uniformity over large areas and reduced reliance on toxic precursors. The researchers then investigated the effect of sulfurization temperature on the formation of a molybdenum sulfide (MoSx) interfacial layer.

"The composition and structural properties of the CZTS layer depend on the deposition process and the sulfurization," explains Dalapati. "By using a single-step sputtering target we were able to produce a thin film with a uniform composition and smooth surface, which limits the formation of defects, and is a highly reproducible process."

The researchers found that the amount of molybdenum lost, referred to as out-diffusing, during the MoSx layer formation varied significantly with changes in sulfurization temperature, and that the overall efficiency of the solar cell was improved by nearly five times when the sulfurization temperature was raised from 500 to 600 degrees Celsius.

"We achieved a solar efficiency of nearly five per cent, and are aiming for around 15 per cent by investigating a suitable buffer and interface layer," says Dalapati.

More information: Goutam Kumar Dalapati et al. Impact of molybdenum out diffusion and interface quality on the performance of sputter grown CZTS based solar cells, *Scientific Reports* (2017). DOI: 10.1038/s41598-017-01605-7

Provided by Agency for Science, Technology and Research (A*STAR), Singapore