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SILICON SOLAR CELLS

Fast anneal fights defects

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Multicrystalline silicon solar cells — enjoying a photovoltaic market share of 65% — are affected by defect-induced degradation, which curbs device performance and is particularly severe in the so-called passivated emitter and rear contact (PERC) architecture. The exact nature of the defects causing the degradation, which can take years to develop under normal operating conditions, is unclear; however, it can be investigated by accelerating the degradation by subjecting the cells to high temperature and light irradiation for a few hundred hours. David Payne and colleagues at the University of New South Wales now show that the degradation can be reduced 80% by using a 10 second annealing treatment at 200 °C under illumination with a high intensity of 44.8 kW m^{-2}. The annealing likely induces a passivation of the defects causing the degradation.

The research team first confirm that the degradation occurs also under carrier injection in the dark, and it is thus generated by excess carriers rather than directly by light. Then they compare degradation in PERC cells from different commercial manufacturers and from wafers at different positions on the same silicon ingot, concluding that there is great variability among manufacturers and positions along the ingot. Finally, the team tested the effects of rapid passivation treatments with varying time and temperature while monitoring cell stability. The rapid annealing significantly reduced degradation after 225 hours of light-soaking at high temperatures compared to control samples. *ED*

BATTERIES

Two-material interface

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Both ionic and electronic conductors are often required in batteries to facilitate the transport of ions and electrons through the active materials. In solid-state batteries, however, the continuous volume changes of the solid active materials can cause severe contact loss with the conductors and consequently break the diffusion pathways, leading to deterioration in performance. This is known as 'active material isolation' in heterogeneous electrode designs, which involve a three-material interface. Kyu Hwan Oh, Se-Hee Lee and colleagues at the University of Colorado at Boulder and Seoul National University have now reported an electrode design with a two-material interface by pairing a mixed ionic and electronic conductor ($LiTiS_2$) with an insulating active material (FeS_2), eliminating the need to have separate ionic and electronic conductors.

Prepared by ball-milling FeS_2, TiS_2 and Li_3N, the FeS_2–$LiTiS_2$ cathode features nanodomains of FeS_2 in amorphous $LiTiS_2$ matrices, maximizing the contact between the active material and the conductor. Compared to a standard FeS_2 cathode, the transport properties are significantly improved in the FeS_2–$LiTiS_2$ system, as manifested by the charge transfer resistance being more than halved. The researchers also showed that the cathode design enables a capacity retention of 62% and an average Coulombic efficiency of 99.8% for 500 cycles. Importantly, the work suggests that it is possible to remove the solid electrolyte (the ionic conductor) and other conductive additives by using just a mixed ionic–electronic conducting matrix. *CZ*

FUELS SYNTHESIS

Not such a vicious cycle

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Thermochemical cycling processes can be used to make useful products such as H_2 and CO from water and carbon dioxide, respectively. These processes require high temperatures, which can be generated by solar thermal concentrators, providing a pathway to convert solar energy into fuels. The approach exploits the fact that redox active materials — such as ceria (CeO_2) — can be partially reduced when heated to high temperatures in inert gas, releasing oxygen. When water or carbon dioxide is subsequently introduced at lower temperature, the ceria is re-oxidized, with concomitant production of H_2 or CO. Syngas (a mixture of CO + H_2) can then be converted into hydrocarbon fuels through other processes. Now, Ivo Alxneit and colleagues in Switzerland show that water and carbon dioxide can be directly converted into methane by thermochemical cycling in the presence of ceria doped with rhodium, with no additional processes.

The researchers cycled the Rh-doped ceria between 1,400 °C and 500 °C over 50 times to reduce and oxidize the ceria sequentially, finding that methane is only produced when water and carbon dioxide are flowed simultaneously. Crucially, the metallic rhodium nanoparticles — the catalytic phase likely responsible for the methane selectivity — are relatively stable to sintering even at the extreme temperatures required. Conversely, nickel-doped ceria, while active for methane production, is not stable due to sublimation and sintering of the metallic nanoparticles. *JG*

ELECTRICITY DISTRIBUTION

Incentives promote investments

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The rapid expansion of distributed electricity generation and the new functions that distribution system operators (DSOs) are called to perform will require €400 billion in Europe by 2020. However the capacity of incentive regulation, introduced in the electricity sectors across Europe, to foster investments of this size is still to be proven. Astrid Cullman and Maria Nieswand from the German Institute for Economic Research shed light on this question by analysing the investment behaviour of 109 DSOs in Germany, finding that the investment rate is higher after the implementation of incentive regulation in 2009 and that the design of the incentive scheme influences the investment decisions of the firms.

Using a microeconometric model that takes into account general and specific investment drivers, such as the number of connection points and the size of the service area, the authors collect financial, technical and regulatory firm-level data for DSOs operating in Germany between 2006 and 2012. The analysis shows that the implementation of incentive regulation through revenue caps had a significant and positive effect on the investments of companies, which tend to behave strategically and invest heavily in the base year. While the study demonstrates that DSO ownership (public or private) does not affect investment decisions, it reinforces that the entire design of incentive mechanisms must be taken into account to provide support to the energy transition process. *AR*

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