50 Years Ago

The mandibular gland secretion of the worker honeybee *Apis mellifera* L., contains 10-hydroxy-Δ^2-decenoic acid and … 2-heptanone … I have shown that 10-hydroxydecenoic acid does not repel foraging honeybees but that 2-heptanone does … Foragers were strongly repelled by the odours of crushed heads and crushed mandibular glands, which contain both 2-heptanone … and 10-hydroxydecenoic acid, but were unaffected by crushed thoraces. The odour of 10-hydroxydecenoic acid neither attracted nor repelled foragers, but 150 μg of 2-heptanone repelled them as strongly as either the crushed heads or the crushed mandibular glands of ten foragers. The ability of the mandibular gland secretion of a forager to repel other foragers probably depends largely, or entirely, on its content of 2-heptanone. It is unlikely that this pheromone is used by foragers to warn others away from an exhausted food source but if, as has been reported, it plays a part in colony defence, perhaps it is released by guard bees to deter potential robbers from the honey stores.
From *Nature* 29 October 1966

100 Years Ago

On October 20 …. large fireballs were observed. The first was seen by Mr J. E. Clark, of Purley, Surrey, and it was estimated as twice as bright as Venus … The second was seen by Mrs. Fiammetta Wilson at Totteridge, Herts, and by Mr. Denning at Bristol. It appeared as a ball of fire streaming slowly along in a level course about 8° above the northern horizon. This fireball was at a great distance from the observers, and probably over the southern region of Scotland. It probably emanated … from a radiant near Zeta Herculis low in the N.W. sky.
From *Nature* 26 October 1916

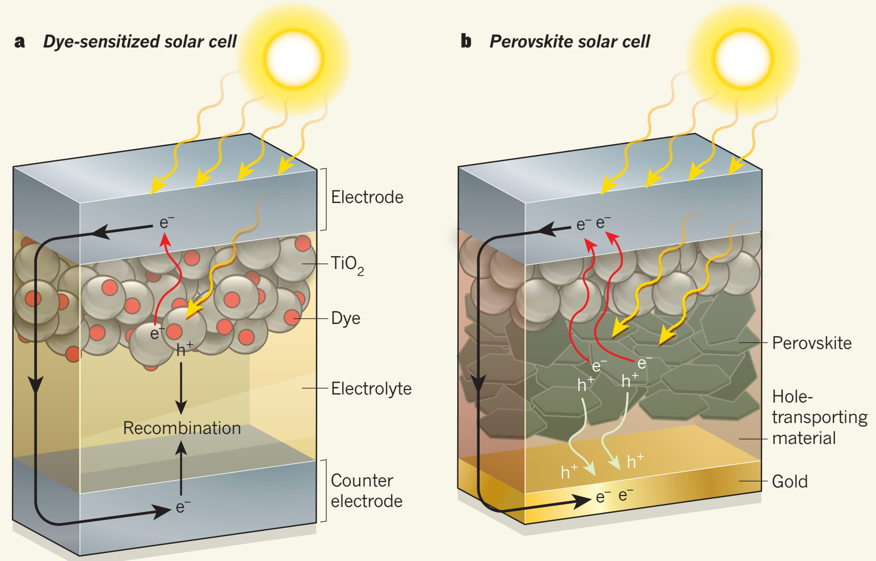

Figure 1 | The evolution of solar cells. In 1991, O'Regan and Grätzel[3] reported a low-cost 'dye-sensitized' solar cell (DSC), which has since led to the development of more-energy-efficient variations such as the perovskite solar cell[4,5] (PSC). **a**, A conventional DSC consists of a film of titanium dioxide (TiO_2) nanoparticles, on which dye molecules are deposited. When sunlight hits the dye, a negatively charged electron (e^-) and a positively charged hole (h^+) are produced. The electron diffuses through the TiO_2 film to an electrode and is subsequently transferred to a counter electrode. Finally, the electron enters a liquid electrolyte before recombining with the hole and being reabsorbed by the dye. **b**, In a modern solid-state PSC, the liquid electrolyte is replaced with a hole-transporting material, and chemical compounds called perovskites act as the light harvesters. In PSCs, gold is commonly used as the counter-electrode material to further enhance the efficiency.

In the past seven years, the architecture of solid-state DSCs has been adapted for solar cells that, instead of dye, use perovskites — compounds that have the general formula ABX_3, where A and B are two different positively charged ions and X is a negatively charged ion. Perovskite solar cells (PSCs; Fig. 1b) have created a tsunami effect among the photovoltaic community because of the excellent light-absorption properties of perovskites. The seminal work of the chemist Tsutomu Miyasaka and colleagues initiated this boom by producing PSCs that used liquid electrolytes[4], and this has been followed by the transition to solid-state PSCs[5]. Several groups have demonstrated that the methylammonium lead triiodide ($CH_3NH_3PbI_3$) perovskite can be used not only as the light-absorbing material, but also as the charge-transporting material[10].

There are several PSC architectures in use today, but the highest reported conversion efficiency (greater than 22%) is based on a structure in which the perovskite is a light-absorbing semiconductor, TiO_2 acts as the electron acceptor, and a poly(triarylamine) polymer is the hole-transporting material (see go.nature.com/2e3rq0e). PSCs have the potential to reach efficiencies of more than 25% and have been recognized by the World Economic Forum as one of the top ten emerging technologies of 2016 because of their potential to replace fossil fuels (see go.nature.com/2dpv26d). Nevertheless, PSCs have many drawbacks, such as poor material stability under excessive heat and light exposure, and toxicity because of the presence of lead.

Further advances in PSCs, through a combination of innovative steps in materials science, chemistry and device technology, could lead to a revolution in the renewable-energy sector. Solar cells have come a long way since O'Regan and Grätzel's landmark paper, and the future looks bright for PSCs as a potential means of obtaining truly renewable energy. ■

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