OI INSPIRATIONAL CASES

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OPEN INNOVATION FOR SMEs

PEROVSKITE PROMISE: FROM RESEARCH LAB TO COMMERCIAL APPLICATION WITH THE SUPPORT OF INDUSTRIAL CUSTOMERS

During her studies a Polish scientist was introduced to perovskite, a material that can convert the energy of the sun into electricity. She immediately saw the industrial potential of the technology and, quite contrary to her own expectations, founded a company which has the potential to transform the solar power business.

- Saule Technologies is a Polish start-up that designed a low-temperature method for manufacturing flexible photovoltaic perovskite cells. It was established in 2014 by a PhD student at the University of Valencia - Olga Malinkiewicz - and two Polish entrepreneurs - Piotr Krych and Artur Kupczunas - to commercialize Olga's invention.
- 2014: The ink-jet printed solar cell was first demonstrated.
- 2016: The first application – a functional mobile phone charger- was successfully demonstrated.
- 2017: Production feasibility was demonstrated and the first flexible perovskite module the size of A4 produced. The stable performance of a perovskite module under water was validated.
- 2018: Saule signed a cooperation agreement with the European construction company Skanska to mount semi-transparent perovskite solar cells on office buildings on a commercial scale. The launch of the prototype production line is expected in autumn 2018.

Origin of the Open Innovation

Perovskites are a diverse class of layered, crystalline minerals commonly found in nature with a wide variety of chemical compositions. These easily synthesized materials are considered the future of solar cells, as their distinctive structure makes them perfect for enabling low-cost, efficient photovoltaics. The research interest in perovskites was stimulated in 2006, when Tsutomu Miyasaka of Toin University in Japan discovered that some perovskites are semiconductors and showed particular promise as the basis of a new type of solar cell. Olga Malinkiewicz, a PhD student, first heard about perovskites while studying at the University of Valencia. She understood the huge potential of the material for the photovoltaics industry: perovskites, like silicon, absorb visible light and they also dissolve in solvents, so that they can be applied to any material: clothing, plastic, even paper.

SAULE TECHNOLOGIES

However, moving from research to any commercial and profitable application involves technical and non-technical challenges. First, as with many new technologies, there is a difference between what works on a small scale in a laboratory and on an industrial scale in a factory. Also, perovskites as a material have their own problems: they tend to be unstable in high temperatures and susceptible to moisture, both of which can cause the cells to degrade. Such properties are not suited for a product that would be expected to last two or three decades in the open air. Secondly, there is fierce competition from the incumbent solar power industry which has invested heavily in silicon technology and knows how to handle it. In addition, the price of silicon-based solar power has decreased substantially over the past decade. Last but not least, the low cost and simplicity of the process to transform perovskites into solar power means that everybody could try it. Competition is therefore high and those who are fast enough to solve technology issues, develop applications and attract the necessary capital will obviously have an advantage.

The OI Journey

Olga Malinkiewicz started working on perovskites while studying at the University of Valencia in Spain. Very soon she developed perovskites with excellent performance (12%). She was also impressed how easily they could be produced. The results of her work were published in the prestigious review *Nature Photonics*. Soon, investors started asking her if she was going to set up a company. In 2014 she moved from Spain to her native Poland, rented laboratory space in Wrocław and, together with two Polish entrepreneurs, Piotr Krych and Artur Kupczunas, established a company - Saule Technologies.

From 2014 the development of one of Saule's key technologies - an ink-jet printing of perovskites on thin plastic film – was a major preoccupation. Scaling up from a small, one-square-centimetre cell to a module a thousand times bigger was a big step. A stable and operating A4-size module was printed three years later, in 2017. The large-scale prototype production line for producing large format modules of one square metre is expected in 2018.

Another critical issue was the material itself. Perovskites are not without their problems: the poor stability of perovskite solar cells is a barrier to practical applications. Degradation can result from thermal and chemical instabilities, as well as exposure to UV light and moisture. To address these challenges, Saule Technologies initiated an EU research project with academic and industrial partners (PERovskite Lifetime Enhancement Survey, PERLE) aiming to prolong the lifetime of perovskite cells through modelling and synthesis of some types of perovskites. Another approach involves sealing the solar cells tight and shielding them from moisture and other elements. Saule launched a project with the Polish plastics firm Ergis Group to develop an ultra-high barrier film, and in 2017, they showcased a working perovskite solar module submerged in water.

With so many applications possible, it is not easy to decide which opportunity to pursue first. Customer commitment to co-develop a joint offering may be a good indicator of that. Saule involves its customers in the development process to gain the required customer perspective. Recently, the SME announced that

they had teamed up with Swedish construction giant Skanska to make perovskite solar cells available for use on a commercial scale in buildings.

Manufacturing technology developments has proved to be capital-intensive, but Saule has been rather successful in attracting investment; so far they secured funding from investor Hideo Sawada, a Japanese discount-travel pioneer, and financial support from the Polish National Centre for Research and Development, along with several research grants worth more than EUR 20 million.

Impact of the OI Collaboration

Having granted Skanska Group the right to incorporate the perovskite printed sheets into some of its components used to make façades, Saule Technologies is looking for like-minded partners. It offers flexible, exclusive and non-exclusive technology licenses for companies active in the Middle East interested in developing, distributing, and integrating Saule's solar cells into building-integrated photovoltaic applications.

Saule's technology has advanced to a stage where customers take part in the product development process, making sure that all their needs and expectations are met. They are looking forward to cooperating with companies that have a long-term renewable energy strategy, including solar energy harvesting technologies.

For example, they see solar energy playing an important role in electric vehicles, supporting batteries by powering internal electronics, such as an air conditioning system.

Although Saule is not the only firm working on technology using perovskites in photovoltaics, with UK-based Oxford Photonics and Australia's Greatcell Solar also in the running, this Polish SME, with an international team of 20+ researchers and over a dozen partners from academia and industry, has undoubtedly the potential to become a globally-known company.

STRATEGY HELPS TO FOCUS

Clear innovation and commercialization strategy brought focus to the R&D effort and underpinned the selection of applications and partners.

PUBLICITY HELPS TO RAISE FUNDS

Media attention helped to attract funding partners when they were most needed for the technology start-up.

PARTNERS MAKE IT FASTER

Working with industry partners accelerated the commercial deployment of different technology applications.

BE PREPARED TO EDUCATE

For many companies, customer education is the challenge that needs to be addressed before, during, and after a product is brought to market. It's hard to convince people to use a new product which is different, even if it works better and provides new opportunities.

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