Bigger picture helps Alf Bjørseth focus on energy and materials projects for the future

Interviewed by **Abdelilah Slaoui** and **Michael de Laine**

With a doctorate in physical chemistry from the University of Oslo, Alf Bjørseth was an associate professor at two Norwegian universities before moving to contract research organizations in Norway and the United States, and then to Norsk Hydro and Elkem in Norway. In 1994, he set up ScanWafer, which produced multi-crystalline silicon wafers, and four other solar industry companies before merging these into REC—Renewable Energy Company. When REC went public, Bjørseth sold his shares and recycled the proceeds, through Scatec, in new companies working with the latest technologies in renewable energy and advanced materials. For Scatec, climate-neutral energy means solar power, offshore wind power, and thorium instead of uranium for power generation. "Materials is a foundation for almost everything we do in our company," Bjørseth said, adding that Scatec group companies focus on titanium, carbon nanotubes, and rare earths. As a scientist, Bjørseth added, "The more I learned about technology, the more opportunities I saw and the stronger was my desire to take one of these opportunities and create something. That has been my driving force, my passion."

***MRS BULLETIN:* What is Scatec's investment philosophy?**

ALF BJØRSETH: Our job is to create value and to make the world a little cleaner; that's our vision. We focus on projects in renewable energy and advanced materials.

Within this framework, we have to seek a significant market for innovations. We do this by looking at "macro trends," that is, where the market is going. We also want to see significant technology improvements in our projects. So advanced technology and growing markets are the combination that we believe in.

We are focusing on two macro trends today. One is climate-neutral energy, which does not emit CO_2, and we are convinced it will continue to grow for the next 50 years. In addition, we think that materials will play a very important role in this century, and we are focusing on three kinds—titanium, carbon nanotubes, and rare earths.

How do you decide on new materials and new technologies?

We start by looking at broader trends, "macro trends," because we need to see a market. That is the most important thing.

Sometimes we are so fascinated by technology that we think we have the solution and then we look for a problem, a much more expensive and time-consuming process.

When we started with solar energy in 1994, it was a very small market. But we had a very strong feeling that this would grow—it's obvious, the sun is free, it's available for everybody, and we can generate energy every place. At that time it was expensive, but today we compete with conventional energy sources in most areas.

What research challenges do you see in photovoltaics (PV)?

The workhorse for solar energy today is based on silicon because it's an abundant material and has very good effects. But the biggest challenge is to find ways of increasing the efficiency of silicon-based solar cells. Everybody is working with cost reductions in all the parts of the production chain, but the effect of increased efficiency influences the cost of the total value chain, including installation. The more efficient a solar module is, the less area we need to cover to produce the same amount of energy.

The first step, of course, is to use *n*-type instead of *p*-type wafers, and then we are looking at ways to increase efficiency by monocrystalline, high-efficiency, advanced cell production, and then come multi-junction cells. And then hopefully sometime in the future, we will add very specific elements such as plasmons.

When we analyze the value chain of producing cells, modules, and wafers, one of the most waste-creating steps is to use a wire saw. To reduce

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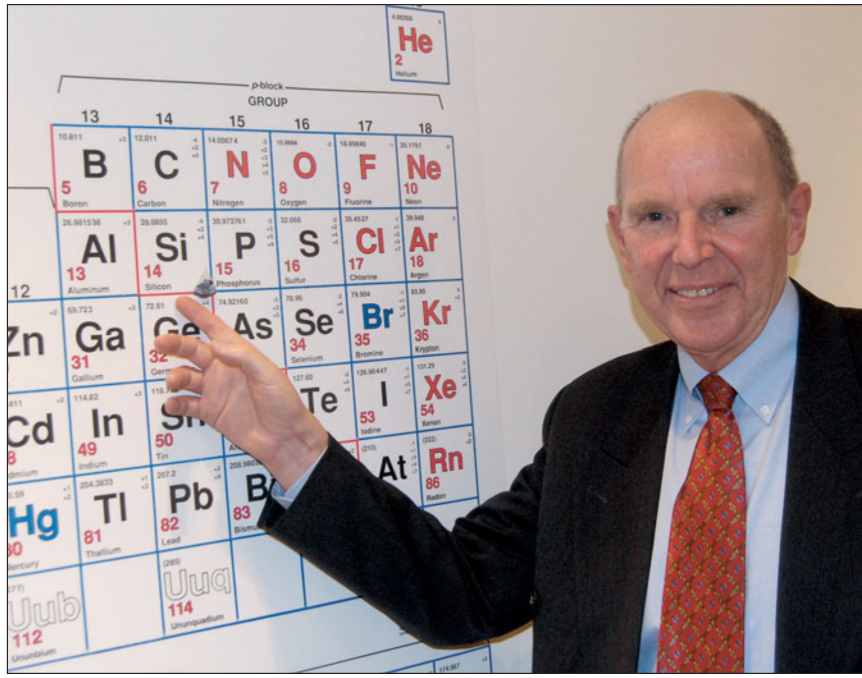
https://doi.org/10.1557/mrs.2013.65 Published online by Cambridge University Press

the waste, it's better to start with a gas instead of polysilicon and then make the wafer directly. For instance, epitaxial growth is a way of doing that.

You need substrates, but if we can reuse the substrate up to, let's say, 100 times, the price of the substrate is not so important.

This kind of crystalline thin-film uses very little high-quality material. And if we cut the cost of crystalline silicon another 50%, and we increase the efficiency, it will be extremely difficult to find alternatives to crystalline silicon.



What is the role of materials in general, whether new materials or existing ones?

In materials, our biggest effort is in new methods to produce titanium components. Titanium is an extremely interesting metal that is hampered by the difficulties in producing components. It requires a lot of machining, and there's a lot of waste of material, which results in very expensive components. We have developed what we call "a near-net shape" production technology for making titanium components that reduces production costs approximately 50%, which is of significant interest to a number of industries.

Titanium is corrosion-resistant to sea water, so we see applications in the offshore oil and gas industry—a very, very important market. Even more important are applications in the aerospace industry. That requires a lot of qualifications. We are almost through the qualification procedures now, and we will be ready in 2013 to start supplying to that industry.

With n-Tec, we have a very good process for making multiwalled carbon nanotubes (CNTs) with "arc technology." In Norway, we have cheap hydroelectric power, so we can use electric arc technology to produce CNTs; very strong particles. We don't use any catalysts and so on, so it's a very pure material. This is one of the few examples in our portfolio where we are still looking for the problem. How do we use the strongest fiber known, which is this multiwalled CNT, in the best possible way? We have certain applications now as additives to composite materials, making them electrically conducting or insulating. We are now trying to add them to metals, which could be extremely interesting; metal CNT composite materials have not been made before, but we are looking at that right now. Mixing CNT and titanium could be very interesting.

We work with rare-earth elements. We see surprising effect for some of these elements in combination with other materials for electronics, for batteries, for magnets.

We work with mining companies—in Australia, the United States, and South Africa—with a side stream of rare-earth elements; they are actually byproducts. Rare-earth elements are a mixture of 17 different elements. You need quite a bit of advanced technology to separate and purify these elements. Developing these technologies is also a big challenge. There have been technologies that are quite polluting and use a lot of solvents and so on, and we want to find metals that are environmentally much more sustainable. We are working with universities and research organizations to actually develop these technologies. We are cooperating with the University of Lund, and we are going to set up the first small plant producing rare-earth elements in Norway in 2013.

How can you foresee future criticality of elements?

That's also a very, very important aspect because, when we see that we are really making an impact on the global resources of a certain element, we need to consider other suitable alternatives. For instance, for conventional silicon-based technology, we use silver, and silver is actually going up in price because we use too much of the material. We have, for CIGS, the question of limited availability of indium, and for cadmium telluride, there's also a question of how large can that industry become. And most likely both these technologies will be limited for availability of materials compared to what we can do with silicon.

In order for PV to grow really big it has to be based on abundant materials such as silicon. Furthermore, Si-based technologies have a large potential for significant cost reductions and to provide solutions with high efficiency and low cost. This will make silicon the prevailing alternative for solar energy. □

https://doi.org/10.1557/mrs.2013.65 Published online by Cambridge University Press

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