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Being Smart with **Solar Technology**

The main objective of the joint venture between Schott and RWE is to become a top player among the manufacturers of photovoltaic solar cells. RWE Schott Solar GmbH in Alzenau has already taken the first giant step in this direction with the opening of its new "SmartSolarFab" plant.

In recent years electricity production by photovoltaic plants, which convert sunlight directly into energy, has developed into an industry with growth rates of more than 30 percent. Experts predict annual growth rates of over 20 percent in the future. This will result in a dramatic increase in sales of more than four billion euros in 2010 to 20 billion in 2020, and ultimately 100 billion in 2030. In light of this situation, the leading service provider for utilities RWE Solutions AG in Frankfurt am Main and the technology company Schott in Mainz decided to combine all their terrestrial photovoltaic activities. RWE Solar GmbH in Alzenau, its U.S. subsidiary ASE Americas, Inc. in Billerica near Boston, Massachusetts, and Schott Applied Power Corporation in Rocklin, California were thus integrated into a single company, which will be jointly managed by RWE Solutions and Schott. The European Commission on Competition Policy has since approved the merger without any restrictions. "I am pleased that we can further boost our existing leading position in solar technology through Schott's know-how in materials research and production and its global presence," says Heinz-Werner Binzel, the CEO of RWE Solutions AG. "We see this joint venture as a further step in positioning Schott as an integrated technology supplier," adds Dr. Udo Ungeheuer, a member of Schott's Board of Management. RWE Schott Solar GmbH has already set its first milestone by

In its 20,000-square meter "SmartSolarFab," RWE Schott Solar will soon be able to realize the entire value-added chain of solar energy – from wafers to finished modules.

Solar units like this one on an Indonesian island are capable of supplying energy to individual buildings and equipment that are not hooked up to a mains supply network.

beginning operations of the so-called "SmartSolarFab" at the end of August 2002 – perfectly according to plan. The largest and most advanced solar cell production plant in Europe went on stream after only nine months of construction. The new building – measuring 350 by 100 meters with a production area of 20,000 square meters – offers space for the entire value-added chain of solar energy, which is unique in the world: the production of silicon wafers, cell fabrication and the ultimate integration of the cells into complete modules. "That makes us the world leader, and therefore, I would say we have every right to use the word 'smart' in this connection." remarks Manfred Remmel, a member of the Executive Board of RWE AG in Essen.

A giant step forward

The work in Alzenau began with the middle manufacturing step, cell production. By the spring of 2003 the first wafer and module production will commence operations. Completion of the expansion project is expected a year later. The total investment for the entire plant will amount to 150 million euros. "Through our new plant with a solar cell capacity of 60 megawatts per year, we have not only strengthened our leading position in Germany and Europe, but have also catapulted ourselves to a ranking among the top five worldwide," says Dr. Winfried Hoffmann, Chairman of the Managing Board of RWE Schott Solar. The capacity in Alzenau until now has been 20 megawatts. This alone shows what a giant step forward "SmartSolarFab" represents.

A patented process

The term "smart" in the new production facility describes not only the high degree of integration. The process for the production of so-called EFG silicon wafers (EFG stands for edge-defined film-fed growth, which refers to the novel growing process used to fabricate the silicon wafers) is, in fact, extremely clever. It has been patented for RWE Schott Solar by its U.S. subsidiary. During production of the wafers, silicon pellets are melted in large graphite crucibles containing octagonal capilliaries. The crystals are slowly grown to a height of six meters at a speed of two centimeters per minute. With a material thickness of just 0.3 millimeters, the octagonal tubes are then conveyed to a laser station where they are cut at the edges and horizontally. While only 40 percent of the precious silicon material is present in wafers produced by other processes, EFG offers a yield of more than 70 percent. In addition, the production process in Alzenau has the lowest levels of maximum energy consumption. Because of almost complete automation and the optimum use of online processes, RWE Schott Solar has succeeded in significantly reducing the energetic amortization time. In other words, the cells now recover from solar radiation the amount of energy required for their production much faster than before. "In this respect, we are well above the world standard," says Michael Harre, who is responsible for Marketing and Sales at RWE Schott Solar.

Good perspectives

Whether crystalline or in thin layers – technologies based on silicon will continue to dominate the market for a long time. On the one hand, the supply of the less expensive scrap silicon – whose quality is not suitable for chip production but sufficient for photovoltaic applications – will decrease with the increase in production of solar cells. On the other hand, however, the required quantities will be so high with increasing demand that a cost-effective production of solar silicon will be possible. Even in the case of high growth for thin-layer technologies, crystalline silicon will still cover at least 50 percent of worldwide solar energy requirements in the year 2020. Experts estimate that 60,000 metric tons of silicon will be consumed in 2020. The long-term advantages of thin layers are the possibility

of large-area coatings, the monolithic series connection of cells, shorter energy return times and the potential for lower costs in the production of modules.

With this intelligent factory, which has created 400 new jobs, RWE Schott Solar has set itself high objectives: compared with its own former production in Alzenau, the new processes aim to achieve an increase in productivity by 50 percent. With the same investment sum and number of staff, the output will increase from 10 to 15 metawatts per year. "These factors will help us survive on the world market," stresses Michael Harre. The existing know-how in the field of thin-layer technologies is further proof of the promising future for the joint venture. ◂

Silicon: a material with a future

120 crystal-growing machines, also known as pullers, for the manufacture of silicon wafers will be installed in Alzenau. These will supply a total of four production lines. The path from a wafer to a solar cell is technically exacting. The high-purity wafer material, positively doped with boron, is coated on one side with phosphorous atoms. After the coating diffuses into the material, a negative doped layer and the pn-junction (the area between conducting sides of a semiconductor, in which the p-side contains acceptor atoms and the n-side donor atoms) are produced. Metallic circuits for current derivation are then mounted. Using a method called PECVD (Plasma Enhanced Chemical Vapor Deposition), an anti-reflection coating is applied in a final step. This gives the cells their typical blue color and increases their efficiency.

Some 90 percent of all the modules that were sold in 2000 are based on crystalline silicon, which is known as c-Si. Forty percent of the wafers are made of monocrystalline material, which is obtained by the Czochralski process. This method of growing crystal from a molten bath is currently used to produce some 80 percent of semiconductor silicon and is named after the Polish-born Professor Jan Czochralski, who developed the process in 1918 for the "Metallgesellschaft" in Frankfurt am Main. The other 60 percent of wafers are made of multicrystalline silicon, which is produced by casting or ribbon/sheet growth methods. The so-called EFG process, which is only used by RWE Schott Solar, belongs in this category.

The semiconductor material silicon still plays a leading role in thin-layer technologies, which both Schott and RWE already used before the joint venture. This is particularly true for amorphous silicon (ASI) passivated with hydrogen. Other technologies have been developed around the world, such as copper-indium-gallium-diselenide (CIGS) and cadmium-telluride (CdTe).

Regions with a poor infrastructure are particularly interesting markets for photovoltaics. Solar power offers the possibility of supplying electricity for lighting, cooling and communications – without burdening the environment.

A photovoltaic unit on the roof of a single-family house: the most solar energy is produced when the modules face south and are installed at an inclination angle of 30°.