

Bad Soden, Germany, 25 July 2011

Sun, gas and energy

Environmentally friendly thin-film solar cells for a variety of uses

Renewables are experiencing a boom worldwide. A great deal of effort is being put into the development and optimisation of the various technologies. In photovoltaics, the thin-film cell opens up new possibilities. Compared with conventional solar cells consisting of silicon crystals, it only requires a fraction of the expensive raw material and is much more flexible to use. GreenSolar Equipment Manufacturing Ltd. in Budapest develops and produces what are called tandem thin-film cells. Their silicon layers are only a few micrometers thick because they are formed from gaseous precursors. Other gases also play an important role in the production of solar panels.

The most important material for the production of solar cells is silicon. The semi-metal has the semiconductor properties that make it possible to convert sunlight into electricity. There is actually an abundance of the raw material: this element makes up around 15 per cent of our planet and about 25 per cent of the earth's crust. Sand, clay, loam and most rocks predominantly contain silicon compounds. Nevertheless, the pure and crystalline form of silicon is a fairly expensive material. And this is the form in which it is used for conventional solar cells, which can now be found on many rooftops. However, the production of pure silicon requires large amounts of energy and is associated with considerable CO₂ emissions. The crystalline form also places considerable restrictions on the possibilities of processing and forming. That is why there is growing interest in types of silicon that are suitable for photovoltaics but require the use of much less material while at the same time being easier to process.

Wafer-thin silicon

These requirements are best met by amorphous and microcrystalline silicon. Since they are only required in extremely fine layers of just a few thousandths of a millimetre, silicon consumption per square metre of solar cell can be reduced by up to 99.9 per cent. Green-Solar uses the so-called tandem process, whereby layers of amorphous and microcrystalline silicon are formed on top of each other. The two materials have different properties; in combination they form a cost-effective solar cell with a relatively high degree of efficiency.

In order to produce the thinnest possible layers, the photovoltaic materials are vapour-deposited onto a base layer. To begin with, therefore, they have to be supplied in gaseous form and fixed to the base in a sophisticated process. This involves the use of silane – a compound of silicon and hydrogen (SiH₄) – as well as gaseous compounds of boron and phosphorus. The latter are needed to facilitate the formation of ions during exposure to sunlight. The flow of these ions generates the photovoltaic current. In addition to the three substances which ultimately remain on the base layer, the process also requires the gases argon, helium, methane, nitrogen and hydrogen. Messer supplies all seven gases to GreenSolar's plants in cylinders – and not only in Budapest, since the company sells not only the collectors but also the machines for making them. The gas supply system, which is specifically tailored to the tandem process, was developed jointly by experts from both companies.

Multiple environmental benefits

The gas cylinders are stored in a safety cabinet. From there the gases are first moved to a mixer, where the specifically tailored gas mixture is prepared. It is then piped to the panel production area. Thanks to the huge saving of material, a lot less energy is used during semiconductor production, and carbon dioxide emissions are also reduced significantly. The thin-film cells are therefore particularly environmentally friendly, both in terms of their production and, subsequently, as a non-polluting power supply.

The thin-film process makes it possible to use different base materials and allows scope for determining the transparency of the collectors. This means that areas which would not be considered for conventional solar modules can be used for energy generation. Environmental efficiency is further enhanced by multiple use: for example, the tandem cells can be used as photovoltaic coating on window glass and facade or roof elements while at the same time serving as sunshades, noise reducers and privacy screens. The panels can also be used for heat insulation or for cooling buildings. They can even function as repeater aerials, for routing mobile telephone signals for example.

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