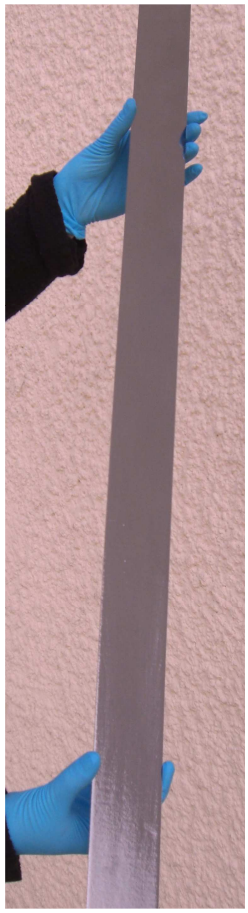
Solarforce™

Thin silicon ribbon: the PV solution for tomorrow

Benefitting from abundant resources, a good conversion efficiency of light and robustness proven over the years, crystalline silicon technologies remain the benchmark for photovoltaic electricity.

The development of silicon wafers currently represents more than half the price of the modules. With its technology directly linked ***to the production of thin ribbons****, Solarforce™ dramatically reduces the cost of wafers and opens new applications for crystalline silicon cells.*



It is a direct technology aimed at producing thin cells ca. 100 micrometers thick, conforming to the "roadmap" of photovoltaic technologies.

The RST Technology of Solarforce™

In the Solarforce™ RST technology, multicrystalline silicon wafers are manufactured from a silicon ribbon, which is obtained by vertical growth on a flexible carbon strip.

It is a technology far more direct than the conventional crystalline silicon technology: it gives access to very low silicon consumption (1 to 2g/Wp), attractive fabrication cost (about 30 cents € / Wp for the silicon wafer), wafers much thinner than in conventional technology (down to 60 micrometers today) and a particularly favorable energy balance.

The advantages of crystalline silicon

With a favorable crystalline structure (large elongated grains), RST technology has a yield potential within the range of crystalline silicon (15% and more), much higher than that of "thin film" technologies.

An attractive price

RST technology has a strong competitive advantage over other silicon technologies; it will reach "grid parity" without recourse to the use of rare materials with uncertain prices and resources.

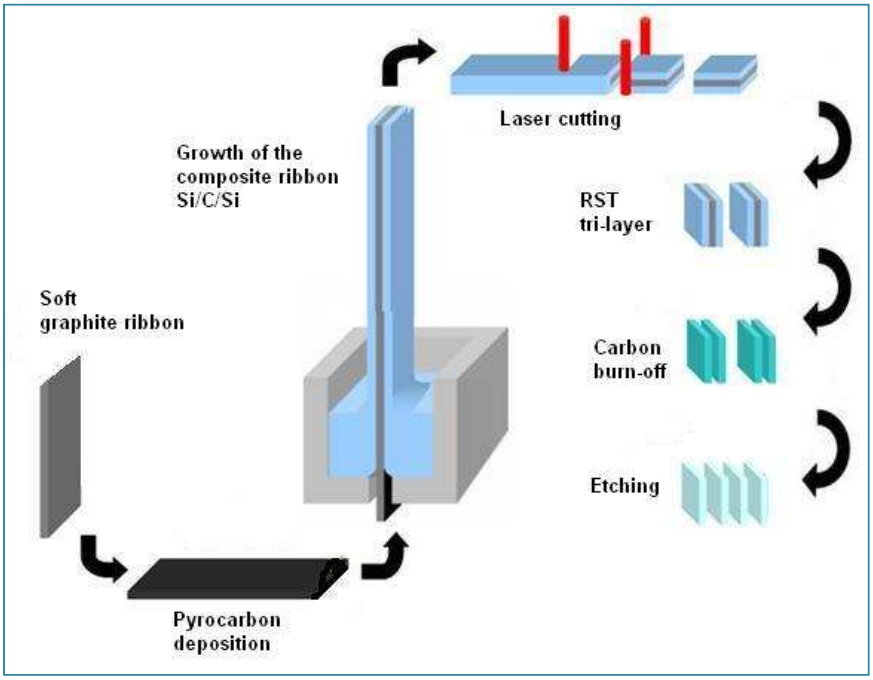
It is a modular technology: equipment prices will decline as production capacity increases.

New applications

The silicon wafers produced by Solarforce are thin (typically from 60 to 120 µm). At these thicknesses, they are flexible and can be incorporated into soft, lightweight modules, paving the way for new applications of crystalline silicon cells.

THE TECHNOLOGY AND ITS DEVELOPMENT AT SOLARFORCE

A brief description of the RST technology



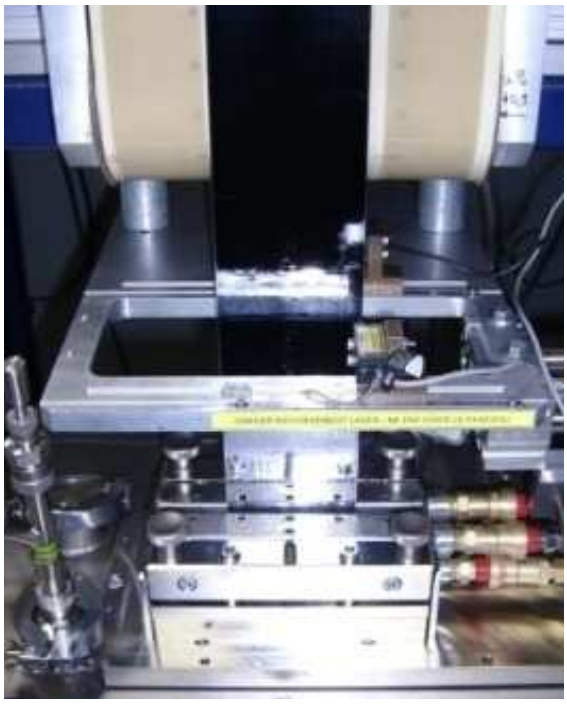
The substrate for the RST technology is a flexible graphite tape, currently produced for other applications.

This tape, after being cut, purified, coated with a film of pyrolytic carbon (carbon deposited at high temperature), goes through a crucible which contains liquid silicon.

The carbon tape emerging from the melt is coated on both sides by a crystalline silicon film.

The silicon-carbon-silicon ribbons thus obtained are then cut by laser, and the carbon substrate is eliminated by a burn-off step in oxygen gas. The wafers thus obtained are finally etched before being transformed into solar cells.

The development of Solarforce™ Technology



For the development of its process, Solarforce has designed, produced and developed all the necessary equipment to implement the various stages up to the silicon wafer. This equipment involves cutting the graphite tape, the high temperature treatment of the carbon ribbon, the growth of the RST ribbon, its laser cutting, burning and etching. The design of the key equipment is the property of Solarforce.

The RST process being modular, these facilities are representative of future industrial machines; they prefigure industrial prototypes.

Solarforce now produces multicrystalline silicon flat wafers 60 to 120 µm thick, which are cut into rectangular shape

Characterization tests on cells made from Solarforce wafers are now carried out in partnership with research centers. The results already obtained in terms of conversion efficiency have now exceeded 15% and should continue to increase with the optimization of the material and the use of cell technologies adapted to the characteristics of RST wafers.

PRODUCTS AND MARKETS

Take advantage of the flexibility of our product

The module is flexible and lightweight: the market for large logistic or commercial roofing

We have been able to demonstrate and measure the flexibility of our product in different configurations.

This quality allows us to design a flexible and lightweight module that can be integrated into large industrial or commercial roofs, the structure of which would not support the weight of conventional modules.

These are very large markets taking advantage of large areas which have no other use.

Flexible modules based on thin crystalline silicon are also suitable for consumer applications.

Non-planar applications and the automotive market

Some applications require non-planar modules, as is the case of the automotive market; this requires efficient photovoltaic products (the available surface area being limited), while embracing the shape of the bodywork. Our product will meet these specifications, opening the way to integrated photovoltaic applications on vehicles (powering of auxiliary equipment, contributing to the recharge of hybrid vehicles).

In the longer term, the RST technology may also be a reference for "conventional" modules.

Thinner cells and technologies that consume less silicon (down to 2 g/Wp): these are the guidelines that emerge from the "Photovoltaic track record» of the International Energy Agency. The RST technology is today one of the few technologies that can meet this necessary evolution.

When it reaches adequate production capacity, the RST technology will be able to take advantage of production costs lower than those of conventional silicon technology. Then, this will be one of the technologies of reference, in a context of very large production volumes, with prices that will enable the sector to develop without subsidies.

Decisive advantages as compared to other PV approaches.

The RST technology allows one to keep the advantages of current mc-Si technology, while considerably reducing material consumption, providing low fabrication cost and opening new markets.

As compared with thin film technology, it offers higher conversion efficiency, without the risks of material supply (In, Se, Te) and of toxicity.

As compared to other silicon ribbon technologies, it is the only one which yields thicknesses much below 100µm and thus is able to enter the large market of flexible PV structures.

THE SOLARFORCE™ COMPANY AND ITS PROJECT

Solarforce today

Solarforce was installed in 2006 at its premises in Bourgoin-Jallieu (between Lyon and Grenoble, France), where it started its industrial prototype equipment during the year 2007. Today, it is finishing its development of the RST technology and the improvement of its prototype equipment.

The company consists of private shareholders, including individuals and investment funds in venture capital.

Its team consists of 14 persons, mostly engineers and technicians.

It has deposited 8 patents worldwide.

It benefits from partnership with leading research centers, directly or through ANR (French National Research Agency) projects which it coordinates, and is supported by Oseo (French public organism supporting innovative SME's) and Feder (structural European Fund for Economic and Regional Development).

Solarforce Strategy

Solarforce's strategic choice is focused on an innovative product.

This strategy would be strengthened by a strong partnership with a manufacturer of cells and/or photovoltaic modules, providing expertise in the development of "cell processes" suitable for thin substrates.

A Three-Year Development Plan

The Solarforce development plan, over the next three years, includes the following components:

- industrialization of the process: long-term testing, improving production, design and construction efficiency, development of a pilot line,
- creation of cells with appropriate technologies adapted to the characteristics of RST wafers, and further optimization of the photovoltaic material,
- realization of prototype modules for targeted applications, and their qualification,
- The preparation of the industrial phase.

The cost of this development is approximately 17 MEuros; State aid can be mobilized in France for this type of development.

The future partnerships

Solarforce is searching for industrial and strategic partners to complete its panel of shareholders with a view to achieve this development plan.