Application Note

Gas blending applications for thin film solar cells development

MCQ Gas Blender 100 Series CVD-related Application

Introduction

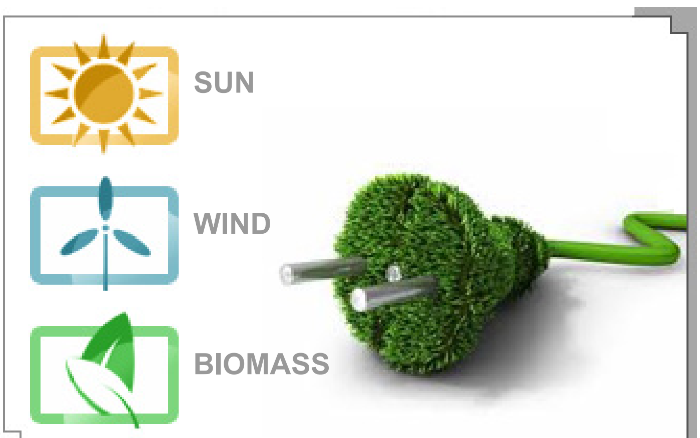
Since the last 30 years, industry has made great strides in the development of sources for sustainable energies (also known as green energies). After the success of anti-global warming awareness campaign undertaken by all countries, switching to green energy production has become a must. A significant optimization of sustainable production techniques, in order to obtain necessary and satisfying results, has become a priority. Between all modern techniques of sustainable energy production, sunlight based technology is one of the most developed and promising application. This technology makes use of solid state devices, called solar cells, which are capable to generate electricity directly from sunlight via photovoltaic effect. Optimization of sunlight technology aims now to increase solar cells efficiency and to lower the production costs of these devices.

Solar Cell Development

Silicon is, and has been, the more used and one of the more suitable material for solar cell manufacturing processes. Apart from its chemical and physical properties (which makes it adequate for sunlight adsorption purposes), silicon has been chosen for its great industrial availability. In the early stages of solar cells development, silicon was obtained from the huge amount of crystalline silicon (c-Si) wafers discarded by microprocessor manufacturing industries. Those type of wafers were made by monocrystalline silicon (an efficient but expensive material), soon replaced by polycrystalline silicon (less efficient but considerably cheaper). Just recently a new technology based on the use of amorphous silicon (a-Si), produced with common CVD techniques, has emerged. Usually we refer to solar cell based on p-n junction principle as first generation photovoltaic cells. The advent of a-Si thin films has allowed to undertake development of two new solar cells generations.

Second generation cells are still based on p-n junction principle but are produced replacing the common thick c-Si with an amorphous silicon thin layer. The main advantage of this devices isn't the efficiency (a-Si solar cells have lower energy conversion efficiency compared with c-Si ones) but the cost. Silicon's cost is by far the largest production factor in solar cell manufacturing and a-Si cells production requires approximately 1% of the silicon needed for typical c-Si cells. Now the new target of the research is the development of third generation cells.

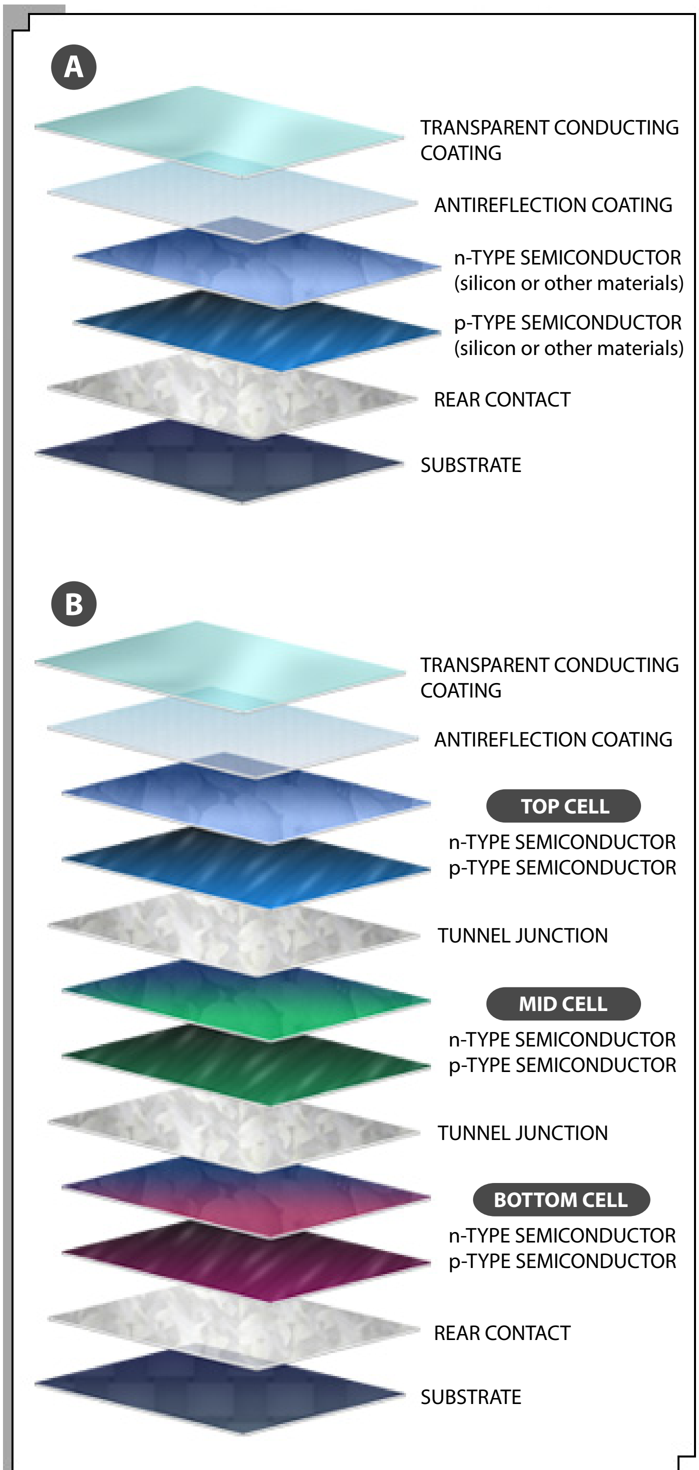
Third generation cells are multi-layer structure devices, composed by a combination of a-Si and c-Si (or other ceramic materials) thin layers. Unlike first and second generation cells, this kind of photovoltaic devices are based on a multi-junction principle. This new approach makes them more efficient in converting sunlight into electricity but also requires more complex and more expensive production process



The three major sources of renewable energy: sun, wind and biomass exploitation

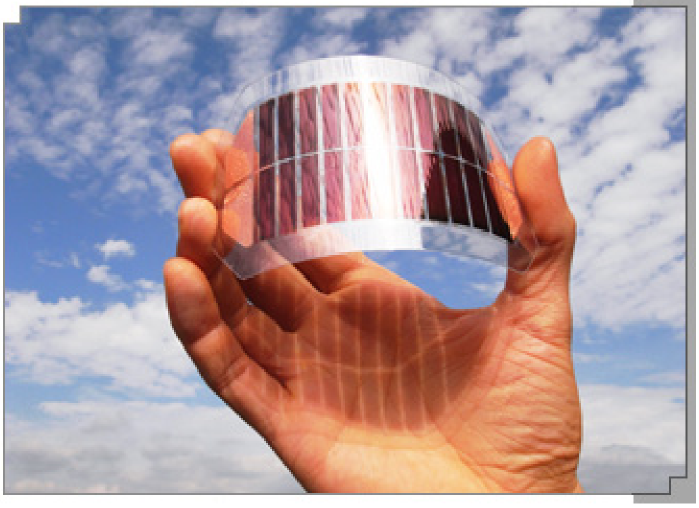
Thin film technology

The great interest around third generation cells derives from the unique features of these devices. Due to their extreme thinness, these new generation solar cells are a flexible material with lightweight physical characteristics that makes them suitable for many applications. Most important



A. Second generation solar cell structure
B. Third generation solar cell structure

A thin fim solar cell application: flexible device



example of this new technology's usefulness are the thin film solar panels. Thin film panels are particularly suitable for buildings installation (usually roofs or other dedicated surfaces) and at the same time they present more advantages then common industrial panels made by first generation solar cells. Aside from their low weight, thin film solar panels are relatively easy to install, can be walked on and aren't subjected to wind lifting.

Production

- Chemical Vapor Deposition

Both second and third generation photovoltaic solar cells share the same production process based on chemical vapor deposition (CVD) techniques. CVD allows to produce devices with a thickness range that varies from few nanometers to tens of micrometers. Since the development of thin solar cells is still at its early stages, the most suitable deposition method and process conditions choice are currently widely debated topics. The major deposition techniques are plasma enhanced CVD (PECVD) and hot-wire CVD (HWCVD), with a slight preference for the latter [1]. Deposition outcomes related to process parameters are well studied. Temperature [2], chamber pressure [3] and substrate material [4] have shown their strong dependence on the thin solar cells produced until now, but obviously a particular attention has also been paid on the working gas mixture. The commonly used gas mixtures are composed by hydrogen (as activator gas) and by a silicon-source gas (usually silane) [5]. The relative amount of components in gas mixture [6] and especially the effect of dynamic mixture changes [7] on the deposition

The MCQ Gas Blender 100 Series

results are crucial parameters of great interest and in order to study them, a suitable instrument is definitely needed.

- MCQ solution

The MCQ Instruments suggests the use of its Gas Blender 100 Series, as the ideal professional product for precision gas mixtures preparations and dynamic gas mixtures applications. The Gas Blender 100 Series is designed to work with 3 components non aggressive gas mixtures. The instrument will be calibrated on customer request and in case of need it's possible to work with different gas settings configurations throughout the use of conversion factor related to each gas media. The Gas Blender 100 Series high precision (1% accuracy for each channel), high repeatability (0,16% of reading value) and the fast response time for setpoint value changes (50 ms) make it suitable for gas mixtures fine blending. Bundled with the instrument the MCQ provides the Gas Mixer Manager, a software (compatible with any Windows-operating desktop and laptop personal computer) that ensures an easy and intuitive way to manage mixtures dynamically.

References

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