Biolin Scientific
[Progress Together]

Attension | [Application Note] 14

Contact angle measurements in solar cell industry

This application note describes how optical tensiometers are utilized in solar cell industry.

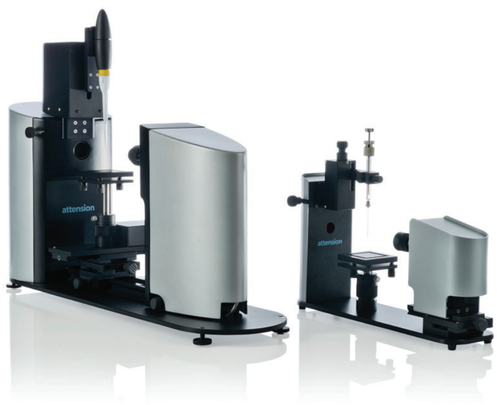
Introduction

Solar cell (also called photovoltaic cell) is an electrical device that converts the energy of light directly into electricity by photovoltaic effect (see Figure 1.). There are several types of solar cells available, the most common one being fabricated on silicon wafer [1]. Other solar cell types include thin film [2], dye-sensitized [3] and organic/polymer solar cells [4]. Although, silicon solar cells are by far mostly used with their over 80 % market share, due to simple fabrication process, other solar cell types offer some additional advantages such as flexibility. There are currently many research groups active in the field of photovoltaics in universities and research institutes around the world. This research can be roughly divided into three areas;

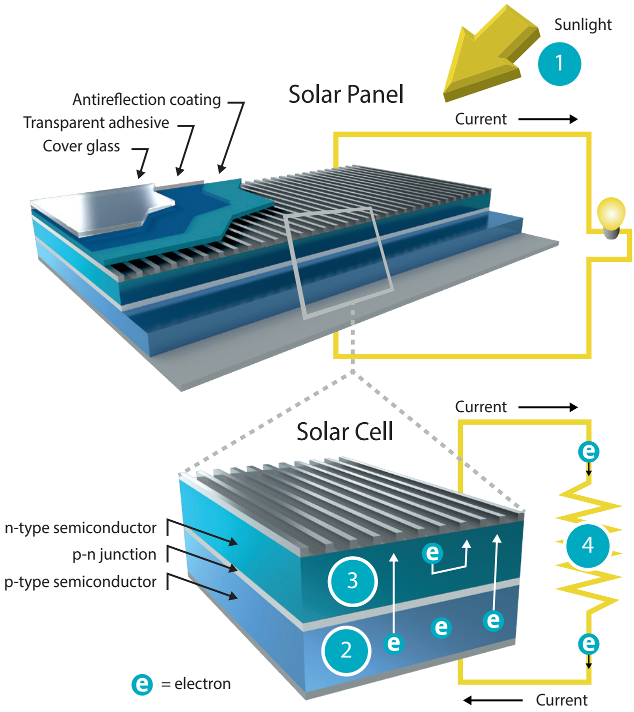
- Making current technology solar cells cheaper and/or more efficient to compete with other energy sources.
- Developing new technologies based on new solar cell architectural designs.
- Developing new materials to serve as light absorbers and charge carriers.

Although, photovoltaic research is done around the world, China is by far the biggest solar cell manufacturer. Solar cells are then connected together to form ready solar panels. There are companies specialized in solar panel manufacturing mainly in China, Japan, US, Germany and Spain.

Tensiometers can be utilized in solar cell and solar panel fabrication and research. Silicon solar cells are fabricated by combining microfabrication techniques, like doping, lithography and etching. Tensiometers are used for example to ensure



suitable surface properties of the wafers at different stages of the fabrication process. In thin film solar cells, a thin layer of material like copper indium gallium selenide (CIGS) works as a photovoltaic material. Tensiometers have been utilized to study the efficiency of these photovoltaic layers. Traditionally the top layer of solar cell is a thin cover glass, coated with some anti-reflection (AR) coating. Anti-reflective coatings are used to increase the absorption of photons and that way the efficiency of the solar cells. Cleanliness of the solar cells can be studied with optical tensiometer [5]: during manufacturing process it is important to ensure good adhesion between different layers. In solar panels, contamination can also decrease the efficiency of the solar cell. In the following case study, optical tensiometer is utilized to study the hydrophobicity of the anti-reflective coatings.



[Figure 1]: Working principle of silicon solar cell and solar panel. Solar cell works by using energy from the sun (1) to excite electrons. The excited electrons jump from lower energy level (2) to a higher one (3) leaving behind a hole. Silicon solar cells use a semiconductor (p-type silicon) to pull an electron in one direction, and another material (n-type silicon) to pull the hole in the other direction. This flow of electrons and holes in different directions leads to an electric currect (4).

Case study: Surface treatment for improved hydrophobicity of antireflective coatings

The sol-gel dip coating technology is a widely used method for producing AR layers on large areas. Porous structure of the film is needed to achieve a refractive index of the film to 1.23 which is required for zero reflection on a glass surface. This is accomplished by adding a "porogen" material to the sol-gel solution and removing it during the heat treatment. This nanoporous silica film is usually rich in residual silanol groups that are very reactive and induce adsorption of water vapour and contaminants. This results into deterioration of the optical properties of the AR films and thus decreases the solar cell efficiency.

San Vicente et al. [6] have investigated the use of hydrophobic hexamethyldisiloxane (HMDS) coating to prevent the contamination of the AR layer. Contact angle measurement (CAM 200, Attension, Biolin Scientific), was used to evaluate the hydrophobicity of the surface after different treatment conditions. Treatment with 100% HMDS solution for 15 min was found to be the sufficient value for this application.

Conclusion

Solar cell research and development is an active field and the efficiency of the solar cells is constantly increasing. Contact angle measurements can be utilized in many stages of solar cell research and solar panel manufacturing as well as in quality control of solar cells. Anti-reflective coatings are used in all solar panels to improve efficiency and lifetime of the solar cells. Study of the surface properties of these coatings is commonly done by using contact angle measurements. Ready solar panels are often too large to be fitted into a laboratory contact angle instrument. Theta QC is a great tool for quality control and testing of solar panels due to its portability and unlimited sample size.

References:

[1] M.A. Green, "Crystalline silicon solar cells", Clean Electricity from photovoltaics Chapter 4 (2001).

[2] M.A. Green, "Thin-film solar cells: review of materials, technologies and commercial status", Journal of Materials Science: Materials in Electronics 18 (2007) S15.

[3] M. Grätzel, "Dye-sensitized solar cells", Journal of Photochemistry and Photobiology C: Photochemistry Reviews 4 (2003) 145.

[4] G. Li, R. Zhu and Y. Yang, "Polymer solar cells", Nature photonics 6 (2012) 153.

[5] Y-T. Cheng, J-J. Ho, C-K. Wang, W. Lee, C-C. Lu, B-S. Yau, J-L. Nain, S-H. Chang, C-C. Chang and K.L. Wang, "Improvement of organic solar cells by flexible substrate and ITO surface treatments", Applied Surface Science 256 (2010) 7606.

[6] G. San Vicente, R. Bayon, N. German and A.Morales, "Surface modification of porous antireflective coatings for solar glass cover", Solar Energy 85 (2011) 676.

Biolin Scientific
[Progress Together]

E-mail:info@biolinscientific.com
biolinscientific.com