

Development of Dye-sensitized Solar Modules for Artistic Designs

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Dye-sensitized solar cells (DSCs) consisting of nanocrystalline TiO₂, dyestuff and electrolyte are attracting general attention as less expensive photovoltaic (PV) modules for next-generation PVs. We have developed two types of DSC modules to meet different artistic designs, and we exhibited them during the period of Aichi EXPO 2005, preceded by an outdoor performance test of a large-scale module^{1, 2)} in collaboration with AISIN SEIKI Co., Ltd.

The first consists of wall-integrated 2.25 m × 2.5 m solar panels based on DSCs³⁾ (Fig. 1) that were developed for a 22.5 m² facade at the TOYOTA Dream House: "PAPI" (Fig. 2). To produce the ornamental features requested by the architect, reflectors of rugged aluminum plates were employed on the backsides of the transparent DSCs, together with a newly-developed frameless structure. On sunny days, the DSC panels have a magenta granitic or marbled appearance, whereas on cloudy days they take on a dark raspberry color and fade into the background, so that the outer glass shields clearly reflect the scenery of the surrounding garden. The electricity generated by the DSC panels is continuously monitored by AISIN SEIKI Co., Ltd., Kariya, wirelessly via a cellular phone communication system. It was revealed that the DSC panels gave a faster rise in electricity generation than a conventional Si solar cell in the morning, and a slower fall in the afternoon, mainly due to a different dependence of electricity generation on the solar insolation angle.

The second is an art object of a plant with transparent leaves of yellow, red, light-green

and dark-green DSCs⁴⁾ (Fig. 3). This object had been exhibited in the "energy garden" in the approach area of the TOYOTA Group Pavilion in EXPO 2005 (Fig. 4). This particular module was developed to symbolize the fact that DSCs are based on a mechanism inspired by photosynthesis in plants. The dependence of the cell properties on the dyes and the treatment of the electrodes has been clarified and optimized. As a demonstration of the generation of electricity, butterflies (which were the principle motif of the main show at the TOYOTA Group Pavilion) flutter and stop using the electricity generated by this plant under intermittent lighting conditions. The freedom of shape and color, and the transparency demonstrated by this object suggest a variety of future applications for this type of DSC.

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References

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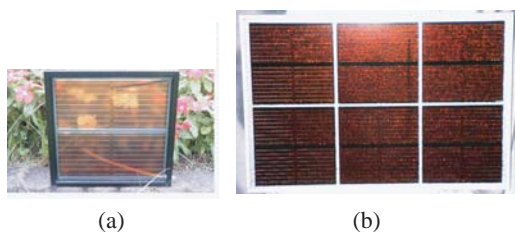


Fig. 1 (a) Transparent dye-sensitized solar cells (240 mm × 240 mm). (b) A unit module composed of 12 DSCs and a reflector of rugged aluminum plates (515 mm × 773 mm).



Fig. 2 The appearance of PAPI with four wall-integrated DSC panels.



Fig. 3 Leaf-shaped transparent DSCs with four colors.



Fig. 4 Art object of a plant with leaves of DSCs colored yellow, red, light-green and dark-green, exhibited at the TOYOTA Group Pavilion in EXPO 2005.