Estimation of the range extension of the mileage of the electric vehicles by the automotive-colored car-roof photovoltaic

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A car-roof photovoltaic has enormous potential to change our society. With this technology, 70% of a car can run on the solar energy collected by the solar panel on its roof. Unfortunately, it is not a simple extension of conventional photovoltaic technology. This paper lists what we need to do to achieve the goal of running a majority of cars on renewable solar energy, after clarification of the difference to conventional photovoltaic technology. In addition to technological development, standardization will be important and this list was made highlighting standardization.

Background

The PV panel on the car-roof may be looked at closely and carefully. Most car customers may hate the exotic appearance of the PV module and PV cells. Since cars relying on solar energy may prevail to 70% of total passenger cars, it is hard to expect customers will accept the current PV modules as a car component. Ideally, the color of the PV panel will be identical to the color of the car body. At the same time, any additional color hampers the light absorption by the solar cell, and thus hampers the energy conversion performance. The development of color control technologies of PV modules with minimum suppression of the photovoltaic performance, but the realization of the fine color suitable to the car body, is vitally important.

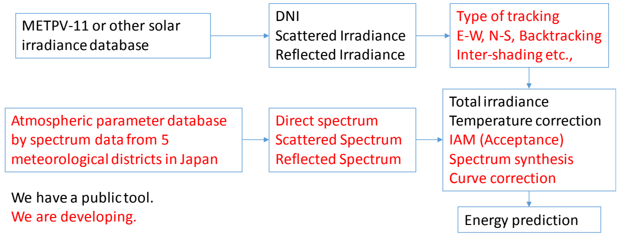
Problem

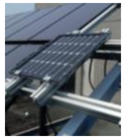
Quantifying the PV performance coated by the automotive paint using a newly-developed energy yield model considering spectrum change by the color and coating layer.

Color	Photo	Illuminated angle	L*	a*	b*
Blue (mica flake)		25°	41.9	-5.1	-36.5
		45°	23.8	-0.7	-19.5
		75°	16.9	1.7	-12.6
Blue (glass flake)		25°	30.3	-6.2	-21.4
		45°	18.6	-1.9	-13.4
		75°	13.4	0.0	-9.0
Green (glass flake)		25°	42.9	-15.7	7.0
		45°	27.0	-9.4	0.9
		75°	18.8	-5.8	-2.4
Red (glass flake)		25°	27.5	17.1	-8.9
		45°	18.2	8.2	-4.3
		75°	14.1	3.8	-2.1
Gold (glass flake)		25°	46.4	-1.5	15.0
		45°	29.4	-1.2	7.5
		75°	20.3	-0.8	3.2
Grey (glass flake)		25°	47.3	-1.8	-6.0
		45°	29.5	-1.3	-4.9
		75°	19.9	-1.0	-4.1

Approach

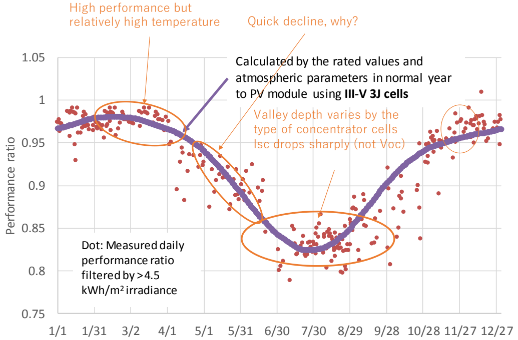
Automotive paint with high transmittance was applied to solar cells with high-power-retention (*Coatings* **2018**, 8(8), 282, and *IEEE Journal of Photovoltaics* **2018**, 8 (5), 1326-1330) was prepared. The spectral transmittance of the coating layer was applied to the newly developed and validated (3-year outdoor monitoring) energy yield model (11th PVPMC 2018/12/4 and IEC TC82 meeting 2018/10/15), and anticipated the energy yield of the car-roof photovoltaic to estimate the mileage of the Electric Vehicle (EV) mounting color-coated photovoltaic modules.

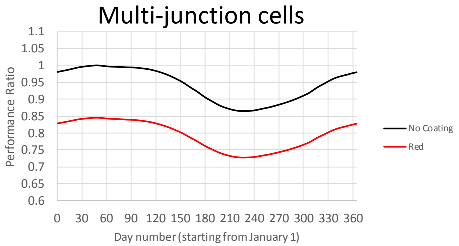


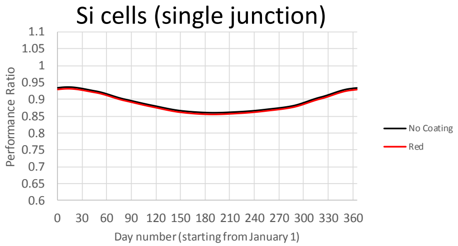


PV module using 3J tandem cell

Area: 983 cm2
STC: 30.7 %
2016/08 – up to now







Result

The annual performance affected by seasonal meteorological fluctuation affected the energy generation performance, but that of Si cells (single junction cell) was not affected by the color coating (after compensation of the total transmittance). On the contrary, that of the multi-junction cell was greatly affected, in other words, the energy yield substantially hampered by the color coating beyond the transmittance loss. It was because of the enhanced spectrum mismatching loss. For the mileage of EV, it can be simply corrected by the total transmittance for Si cells, regardless seasonal meteorological change. However, detailed spectrum calculation is necessary to anticipate the energy yield to the color-coated multi-junction cells.

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