

Joint Studies Programs

As one of the important functions of an inter-university research institute, IMS facilitates joint studies programs for which funds are available to cover the costs of research expenses as well as the travel and accommodation expenses of individuals. Proposals from domestic scientists are reviewed and selected by an interuniversity committee.

(1) Special Projects

A. Novel Power Generation System with a Power Delivery Integrated Circuits, suitable for Energy Harvesting

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Recently, energy harvesting technology has been intensively investigated not only for saving natural resources but for applying to sensors or mobile devices.¹⁾ The project is proposing a novel power generation system suitable for energy harvesting. Generally, natural power sources are spread over the world, but they are thin and are unstable, influenced by the circumstances. Moreover, the generated voltage by conversion devices is low (< 1.0). So, it is difficult to use conventional power generation system, applied to Silicon based Solar Cells. Now, we developed a dedicated device, named Power Delivery Integrated Circuits (PDIC)²⁾ in order to collect the electric power effectively, and propose a novel power generation system. For the verification of its effectiveness, we carried out a field test, utilizing a Dye Sensitized Solar Cell (DSSC) as an energy conversion device, since it is applicable to symbiotic power generation system with plants.

Concept of proposed power generation system is shown in Figure 1. The bunch of DSSCs is connected in parallel to the PDIC. The summation of electric power is outputted in “PW_SUM” terminal. Since inactive DSSCs, which are determined by the comparison data of generated voltage with the reference voltage “VREF,” are disconnected from the system, no leakage current flows toward inactive DSSCs. By using transfer-gates, there is little voltage loss between DSSCs and PW_SUM. For actual use, a DC-to-DC converter is connected to the driven load, if necessary.

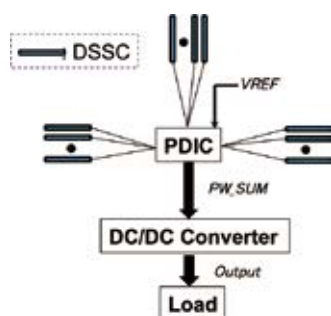


Figure 1. Concept of Novel Power Generation System.

The field test photo is shown in Figure 2. A hand-made DSSC consists of TiO_2 film deposited on FTO, together with dye and electrolyte. The counter electrode is made of platinum film. Electric contact between the TiO_2 particles was produced by sintering with sophisticated temperature ramping sequence. In this Figure, 16 DSSCs are connected to the PDIC.



Figure 2. Field Test Photo.

Figure 3 shows the PW_SUM voltage wave form with 100Ω resistor load. In the Figure, at first, the PDIC disconnects all the DSSCs from the system. Within this reset and monitoring period, PW_SUM naturally stays low. Next, these DSSCs are connected one by one to the system. As High “Dout” means the DSSC is active, the Figure shows all of the 16 DSSCs are active. If the load impedance of PW_SUM is high enough, the voltage reaches inherent voltage rapidly, but if the impedance is low, the wave form looks like stairs as shown in the Figure. So, the PDIC, accumulating the power of DSSCs, works properly as designed. Since the PDIC was designed, and was fabricated with the $0.18\mu\text{m}$ CMOS, no DC current flows except for the voltage monitoring period. Note that it is easy to save PDIC power consumption negligibly small in comparison with the generated power, because the circumstance of the system changes gradually and the monitoring period can be set as long enough.

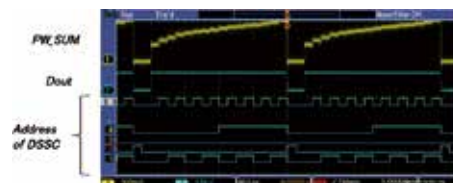


Figure 3. PW_SUM wave form with 100Ω load.

Currently, the characteristics of DSSC are sensitive to fabrication process parameters. The variation is detected by the PDIC. Figure 4 shows open-circuit-voltage variation of 16DSSCs, which is monitored by changing VREF. If VREF is

500 mV, all the DSSCs are active. But, if VREF is raised to 600 mV, 10 out of 16 DSSCs go inactive. Thanks to the parallel connection, a few failure DSSCs give little affection to the whole system performance. But, as the location of an inactive DSSC is easily identified, it can be replaced, if necessary.

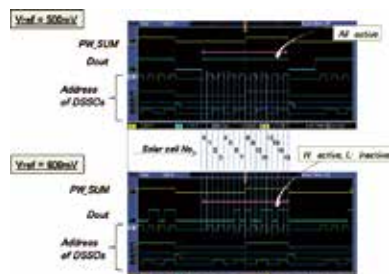


Figure 4. Dout dependence on VREF. Active or inactive states of individual DSSCs are shown.

By the field test, using DSSCs, proposed power generation system is demonstrated to work well. The future work is to improve the performance and to add some functions to the PDIC by feed-backing the data of field tests.

Acknowledgement

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References

- 1) <http://paulinevandongen.nl/projects/wearable-solar-shirt/>
- 2) J. Miyamoto, M. Hiramoto, T. Kaji, M. Sato, H. Itoh and A. Kato, "Development of a Power Delivery IC for Wavelength Selective Solar Cells," Institutes for Molecular Science, *Annual Review 2014*, p. 114 (2015).

(2) Research Symposia

(From Oct. 2014 to Sep. 2015)

Dates	Theme	Chair
Nov. 21–22, 2014	Workshop on Next-Generation Synchrotron Light Sources —Towards a Road-Map of Synchrotron Light Sources in Japan beyond 3 rd Generation Sources and SASE-FEL	KATOH, Masahiro
Dec. 20, 2014	Solution Scattering as Research Tools of Molecular Systems	AKIYAMA, Shuji
Jan. 6– 7, 2015	Frontier of Bioinorganic Chemistry and Future Prospect: Elucidation of Functional Mechanisms of Metal Ions and Biomolecules, Their Modeling and Application	HAYASHI, Takashi AONO, Shigetoshi
Feb. 21–23, 2015	Workshop on Hierarchy of Quantum Mechanics	SHIKANO, Yutaka
Mar. 15–16, 2015	Construction and Function of Superstructure Compounds Containing Metal Ions—The Current Situation and Future Prospects of Interdisciplinary Fields of Coordination Chemistry	NIHEI, Masayuki MURAHASHI, Tetsuro
Apr. 20–21, 2015	Thinking of Proton Permeation inside Membrane Protein	KANDORI, Hideki IINO, Ryota
Jun. 12–13, 2015	Supramolecular Dynamics at the Interface of Chemistry and Biology	UENO, Takafumi IINO, Ryota
Jun. 27–28, 2015	Meeting on Chiral Magnetism and Optical Properties	INOUE, Katsuya OKAMOTO, Hiromi
Sep. 7– 8, 2015	Future Perspectives of Soft X-Ray Imaging	OHIGASHI, Takuji
Jun. 27, 2015	Preparation Meeting for 55 th Young Researchers Society for Molecular Science, 2015 Summer School	TANAKA, Shunsuke FURUTANI, Yuji

PROGRAMS

(3) Numbers of Joint Studies Programs

Categories		Oct. 2014–Mar. 2015		Apr. 2015–Sep. 2015		Total		
		Regular	NanoPlat	Regular	NanoPlat	Regular	NanoPlat	Sum
Special Projects		0		2		2		2
Research Symposia		5		4		9		9
Research Symposia for Young Researchers		0		1		1		1
Cooperative Research		35	31	33	35	68	66	134
Use of Facility	Instrument Center	20	61	7	46	27	107	134
	Equipment Development Center	6	4	4	5	10	9	19
Use of UVSOR Facility		63	24	57	16	120	40	160
Use of Facility Program of the Computer Center						199*		199*

* from April 2014 to March 2015