Superiority of Asymmetric Waveguide-Coupled Scheme to Spectrum-Splitting Multijunction Design

Jiaxing Yu[1], Xingbai Hong, Nobuo Sawamura, and Akira Ishibashi
[1]*NanostrResearch Institute for Electronic Science, Hokkaido University, Sapporo, Hokkaido 001-0020, Japan*

1. Introduction

Unlike conventional spectrum-splitting system [1], which need human to split the spectrum and the performance of the whole system is greatly influenced by the incoming sunlight. In our asymmetric waveguide coupled concentrating solar cells, how to make spatially propagating light efficiently convert into wave light is of vital importance for the research. We found that the space inversion (left and right) [2] in symmetric structure, coupled with time-reversal symmetry, light that has been convert to two-dimensional from three dimensions will go back to three dimensions. Realizing the aforementioned WG is. A top view of a prototype of our new concentration solar cell system is shown in Fig.1. Photoharvesting or photo-reception part of 2D-PhotoRecepto-Conversion (2DPRC)is composed of redirection waveguide (RWG), in which the sunlight coming from the sky above with various incident angles results in 2D propagating light. The first layer of RWG, the bottom front in the left bottom inset of Figure 1, is so designed as to make the sunlight coming with various tilt angles go perpendicularly upward in Figure 1. The first layer is called photo-propagation direction convertor (PDC). The sunlight, via PDC, eventually goes into the 2D waveguide, of the RWG, as shown at the top of the side view in Fig. 1.

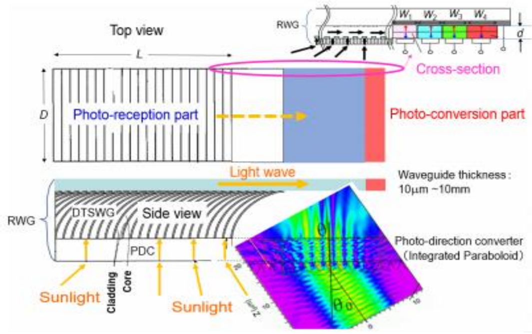

Fig. 1. 2D-connected PhotoReceptor-Conversion Scheme (2DPRCS) realized by redirection waveguide (RWG).

2. Experimental Results

We have proposed to use PDMS, i.e., silicone elastomer and silicone elastomer curing agent. In our experiments, these samples have different base/agent ratios, which means different degrees of cross-linking. For this research, a series of PDMS network samples with different base/agent ratios are used to explore the relationship between modulus changing and the different amount of PDMS network's cross-linking. Finally, we made testing force experiment to test the Young`s module of the mixtures. The Young`s module has been tested by this instrument and the result is shown in the inset of Fig. 2. In Fig. 2, reverse function curve fitting is done to describe the relationship between PDMS network elastic modulus and its base/agent ratios.

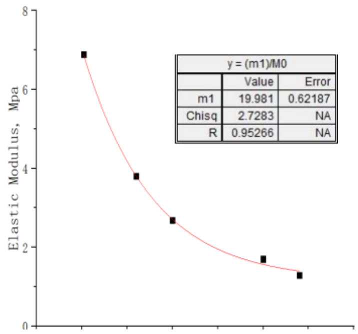

Fig 2. The results of PDMS network base/agent ratio(right)

3.Conclusion.

We have proposed 2DPRC scheme, it would be easier to fabricate their [2]`s system. Besides, we have designed a suitable instrument for PDMS network compression based on the scale and displacement gauge, and we find that PDMS can be potential material to fabricate waveguides. The new waveguide with the discrete translational symmetry would serve as a key component for excellent concentration photovoltaic systems with high conversion efficiencies.

Acknowledgement
This work is supported, in part, by the Network Joint Research Center for Materials and Devices and Dynamic Alliance for Open Innovation Bridging Human, Environment and Materials.

References

[1] Matthew D. Escarra, Sunita Darbe, Emily C. Warman, and Harry A. Atwater 2013 IEEE 39th Photovoltaic Specialists Conference (PVSC)
[2] A. Ishibashi, Y. Okura and N. Sawamura, Energies 2020, 13(19), 5234-1 - 5234-16