Ball Grid Dye Sensitized Solar Cell with Hybrid Copper Polyimide substrate and Carbon Catalyst

Junya Takashima, Takuya Fujii, Keizo Furusaki
R&D Center NGK SPARK PLUG CO., LTD
2808 Iwasaki, Komaki, Aichi, 485-8510, Japan

Introduction

Dye Sensitized Solar Cell was reported in Nature[1] by Prof. Grätzel of Swiss Federal Institute of Technology at Lausanne in 1991, since then the subject has been actively studied by many researchers because of the economy of manufacturing process and less environmental hazard.

In these days, 11% conversion efficiency was reported[2,3] by small size cell. But in large size cell, so far maximum 8% conversion efficiency has been reported.

One of the major challenges of enlarged DSC cell is how to design efficient current collection grid without sacrificing active surface area. In case conventional grid design which uses silver lines with anti corrosive coat, bigger the cell size, wider the lines, in order to maintain low electric resistance, which reduces active surface area for power generation.

We have devised a new grid design which is characterized by ball interconnects joined by conductive copper via through the substrate.

We named this structure “Ball Grid DSC (BG-DSC)”.

Fig.1 describes cross section of this configuration.

A hybrid copper polyimide flexible substrate is used as current collector for both electrodes. (Fig.2).

The unique polymer cored solder balls (micro pearl SOL, Sekisui Chemical) are used as dot interconnects for FTO/TiO_2 anode. Because of their vertical current flow to copper layer inside the substrate, area loss of active TiO_2 surface can be minimized. Moreover, short path to the copper layer significantly contributes efficient current collection even in large size cell.

Copper layer is protected by polyimide surface coat with dense carbon overcoat. On the dense carbon layer, active carbon catalyst layer is formed for cathode reaction of DSC cell.

Followings are advantages of this configuration

- Very high active area efficiency is obtained. (Active area space reaches 95%)
- No limitation for enlarging cell size in terms of efficient current collection.
- No Platinum catalyst necessary for cathode reaction.

Experimental

80mm square size Ball Grid DSC is shown in Fig. 3. This cell shows almost same conversion efficiency as 5mm square small cell with platinum catalyst (Fig.4)

The detail will be presented at the conference.

References

1) B. O’Regan and M. Grätzel, Nature **353**, 737 (1991).
2) Y. Chiba, A. Islam, Y. Watanabe, R. Komiya, N. Koide and L. Han, Jpn. J. Appl. Phys., **45**, L638 (2006).
3) M. K. Nazeeruddin, F. D. Angelis, S. Fantacci, A. Selloni, G. Viscardi, P. Liska, S. Ito, B. Takeru and M. Grätzel, J. Am. Chem. Soc., **127**, 16835 (2005).

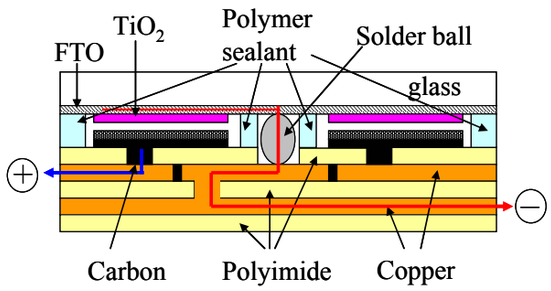

Fig. 1 Cross section of the Ball Grid DSC

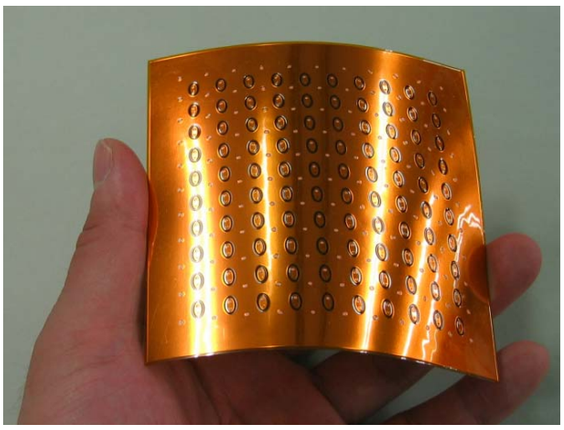

Fig. 2 Hybrid copper polyimide flexible substrate

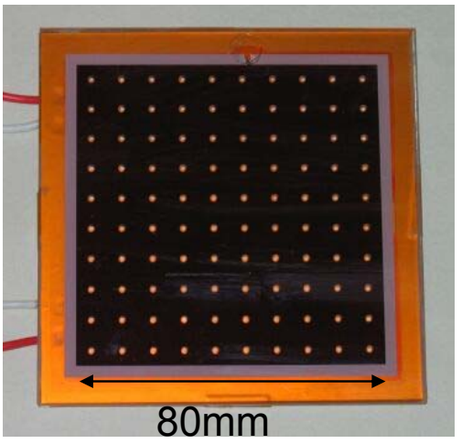

Fig. 3 80mm square size Ball Grid DSC

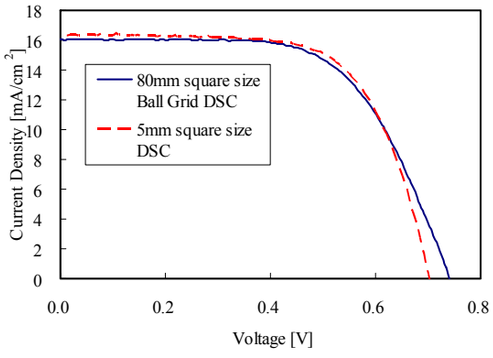

Fig. 4 Photocurrent-Photovoltage characteristics of the 80mm square size Ball Grid DSC compared with 5mm square size small DSC