Proposal of Integrated Sensitized Solar Cell Films Based on Sputtered ZnO Thin Films

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1. Concept and Advantages of Waveguide-Type Sensitized Solar Cells

The dye-sensitized solar cell (DSC) is expected to be the next-generation device for energy conversion.[1] One of the issues in the DSC is the internal resistivity. In conventional DSCs, as shown in Fig. 1(a), the porous structure of the semiconductor degrades the crystalline quality, suppressing electron mobility, and makes the carrier path in the semiconductor narrow.

To solve this problem, we propose the waveguide-type sensitized solar cell based on sputtered oxide semiconductor thin films shown in Fig. 1(b). Here, guided lights in the thin films are used to generate photocurrents instead of normally-incident lights. In this configuration the lights pass through a substantial number of dye molecules to enhance the light absorption.

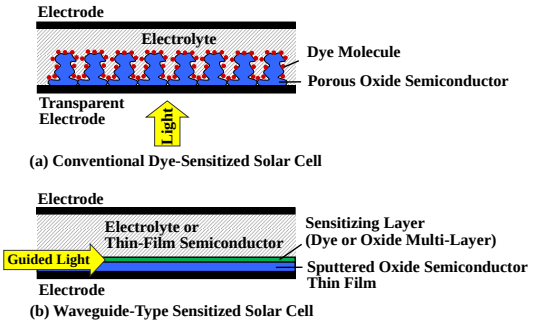

Fig. 1 Waveguide-type sensitized solar cell.

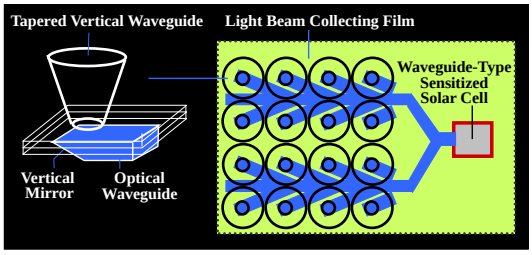

Fig. 2 Integrated sensitized solar cell film.

A schematic illustration of the proposed integrated sensitized solar cell film is shown in Fig. 2. The waveguide-type sensitized solar cells are embedded in a light beam collecting film consisting of two stacked films; a film with tapered vertical waveguides and a film with planar waveguides having vertical mirrors. Incident lights are collected by the waveguides, and are guided to the solar cells. Expected advantages are as follows.

-Reduction of semiconductor consumption.
-Availability of optical circuit functions.
-Light-weight and flexible characteristics.

In the present work, sensitization of sputtered ZnO thin films were investigated.

2. Sensitization of Sputtered ZnO Thin Films

We previously succeeded in dye sensitization of vacuum-evaporated ZnO films[2] by the liquid-phase molecular layer deposition (LP-MLD).[2-4] To improve the film quality, we attempt to replace the ZnO films with sputtered films.

Fig. 3 shows two sensitization processes for the sputtered ZnO thin films; (a) by a multi-dye stacked structure grown using LP-MLD with sequential deposition of p-type dye (rose bengal: RB) and n-type dye (crystal violet: CV) on ZnO and (b) by a ZnO/Cr_2O_3 multi-layer, which is regarded as a multiple quantum wells with different well widths. These structures are expected to widen the photocurrent spectra as shown in (c).

For experimental results, they will be presented in the conference presentation.

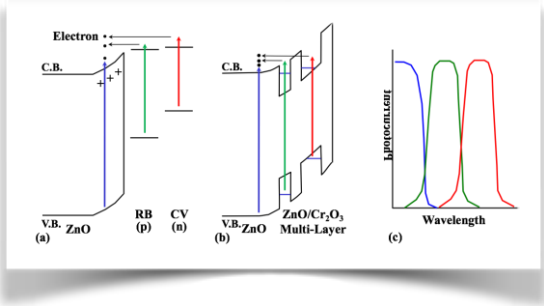

Fig. 3 Proposed models for sensitization of sputtered ZnO with (a) a multi-dye stacked structure and (b) a ZnO/Cr_2O_3 multi-layer. (c) Expected photocurrent spectra.

References

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3 T. Yoshimura, Japanese Patent, Tokukai Hei3-60487 (1991) [in Japanese].
4 T. Yoshimura, Japanese Patent, Tokukai 2012-045351 (2012).