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P-type Cu_2O-based heterojunction solar cells fabricated with n-type ZnO thin film prepared by electrochemical deposition method

Toshihiro Miyata, Hiroki Tokunaga and **Tadatsugu Minami**
Kanazawa Institute of Technology, Japan

Recently, substantially improved conversion efficiency has been reported in p-type Cu_2O sheet-based heterojunction solar cells with n-type oxide semiconductor thin films prepared by the pulsed laser deposition (PLD) method. However, PLD has some disadvantages as a practical preparation method, such as low deposition rate, small deposition area and high cost. On the other hand, the electrochemical deposition (ECD) method is a deposition technique that has potential to solve these problems. This paper describes the fabrication of Cu_2O based heterojunction solar cells using n-type ZnO thin film prepared by the ECD method. The n-type ZnO thin film layer was prepared on a p-type Cu_2O: Na sheet using the following ECD process. Initially, a zinc nitrate aqueous solution was prepared with 0.22 M zinc nitrate and de-ionized water; after that, a 0.3 M HCl or 0.1 M KOH aqueous solution was added to adjust the pH. Next, a p-Cu_2O: Na sheet was immersed in the above solution. The photovoltaic properties were strongly dependent on the fabrication conditions of n-type ZnO thin films. For example; the current density-voltage (J-V) characteristics of AZO/n-ZnO/p-Cu_2O: Na solar cells showed strong dependence on the pH of the zinc acetate aqueous solution, obtaining significant improvement with a pH value of 4.9 in Figure 1. Figure 2 shows typical J-V characteristics for AZO/n-ZnO/p-Cu_2O solar cells prepared under optimized deposition conditions, such as film thickness of the n-ZnO thin film. The same structure of a Cu_2O heterojunction solar cell using n-type ZnO thin films was prepared by PLD, and the J-V characteristics are also shown in Figure 2. It should be noted that the J-V characteristics of the AZO/n-ZnO/p-Cu_2O solar cells were the same as those when using the PLD method.

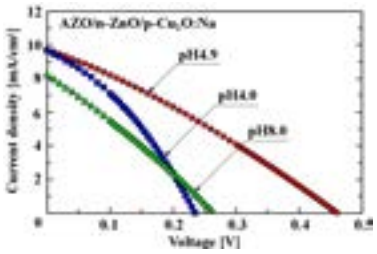

Figure 1: pH dependence of zinc acetate aqueous solution for J-V characteristics of AZO/n-ZnO/p-Cu_2O: Na solar cells

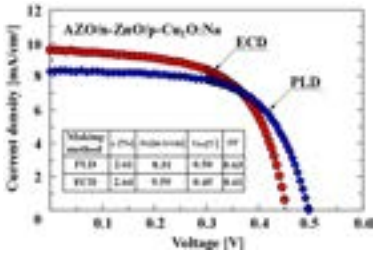

Figure 2: Typical J-V characteristics of AZO/n-ZnO /p-Cu_2O heterojunction solar cell under optimized preparation conditions

Recent Publications

1. T Minami, J Yamazaki and T Miyata (2016) Efficiency enhanced solar cells with a Cu_2O homojunction grown epitaxially on p-Cu_2O: Na sheets by electrochemical deposition. MRS Communications 6:416-420.

2. Y Nishi, T Miyata and T Minami (2016) Electrochemically deposited Cu_2O thin films on thermally oxidized Cu_2O sheets for solar cell applications. Solar Energy Materials and Solar Cells 155:405-410.
3. T Minami, T Miyata and Y Nishi (2016) Relationship between the electrical properties of the n-oxide and p-Cu_2O layers and the photovoltaic properties of Cu_2O-based heterojunction solar cells. Solar Energy Materials and Solar Cells 147:85-93.
4. T Minami, T Miyata and Y Nishi (2014) Cu_2O-based heterojunction solar cells with an Al-doped ZnO/oxide semiconductor/thermally oxidized Cu_2O sheet structure. Solar Energy 105:206-217.
5. T Minami, T Miyata and Y Nishi (2014) Efficiency improvement of Cu_2O-based heterojunction solar cells fabricated using thermally oxidized copper sheets. Thin Solid Films 559:105-111.

Biography

Toshihiro Miyata is a Professor at the Kanazawa Institute of Technology (KIT), Japan and a Researcher of the Optoelectronic Device System R&D Center at KIT. His interests focus on optoelectronic devices, especially solar cells using Cu_2O. He has completed his BE degree in Electronics Engineering at KIT, 1987 and ME and Doctor of Engineering degrees at KIT in 1989 and 1992 respectively. During the period 1992 to 1993, he was a Visiting Scientist at the Micro Systems Technology Laboratory at MIT, USA.

tmiyata@neptune.kanazawa-it.ac.jp

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