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Characteristics of perovskite solar cell with UV down-converting layer and function as an arc detector

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Abstract

In this study, we obtained the most stable temperature in the heat treatment process after the deposition of the perovskite layer in the production of perovskite solar cells (PSCs). Based on this, UV treatment was performed to produce PSC, which is 4% more efficient than conventional cells.

1. Introduction

The MAPbI3 layer, which is most commonly applied to perovskite solar cells (PSCs), is showing the maximum photoelectric efficiency in the visible light region and the photoelectric efficiency is lowered in the light of the 300 nm wavelength region. A UV down-shifting layer was added to convert the ultraviolet light into visible light to produce electricity. The UV down-converting layer was fabricated by coating $ZnGa_2O_4:Eu^{3+}$ ($ZGO:Eu^{3+}$)by sol-gel method.

In this study, it was confirmed that the coated phosphor on the back side of the solar cell can generate additional current according to UV irradiation, and it can be used as a sensor because it can detect the arc generated in the power line through the commercialized short pass filter.

2. Experiments & discussion

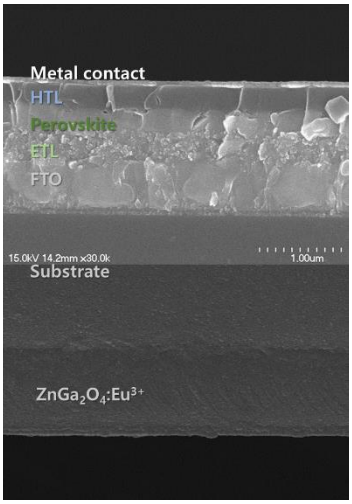

Figure 2. Cross-sectional SEM image of fabricated perovskite solar cell and $ZGO:Eu^{3+}$ film

In Figure 1, the thickness of the coated ZGO: Eu^{3+} is about 1 μm, which is the result of coating the ZGO: Eu^{3+} precursor 8 times. The ZGO: Eu^{3+} precursor was coated on titanium diisopropoxide film to improve coating efficiency. Compact and Mesoporous Tio_2 were applied as an ETL and its thickness is about 300nm. Methylammonium lead iodide was applied as an perovskite layer.and its thickness is about 300nm. Li-TFSI and 4-TBP doped spiro-OMeTAD was applied as an HTL and its thickness is about 200nm. Finally, 60nm gold was deposited by thermal evaporation.

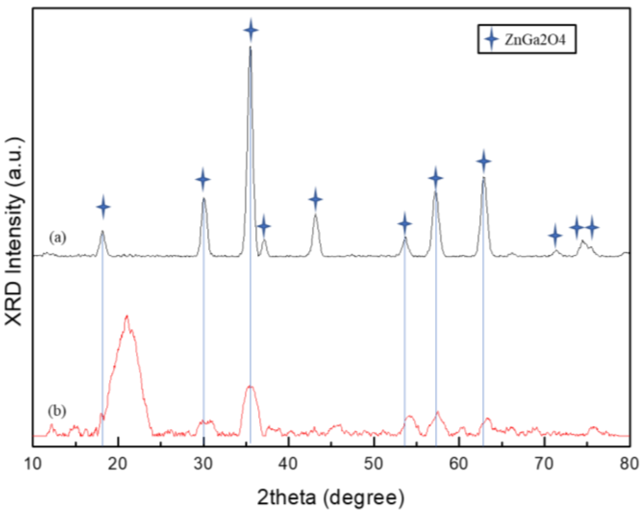

Figure 1 XRD patterns of (a) $ZGO:Eu^{3+}$ powder obtained by heating the sol-gel solution and (b) $ZGO:Eu^{3+}$ thin film on the substrate.

Figure 2. (a) is an XRD pattern of synthesized $ZGO:Eu^{3+}$ powder sintered at 973K. Peak of (111), (220), (311), (222), (400), (422), (511), (440), (620), (533), (622) can confirmed and it indicates $ZGO:Eu^{3+}$ powder has spinel structure. Figure 2. (b) is an XRD pattern of ZGO:Eu3+ down-converting layer which is coated by sol-gel spinning and sintered at 973K. The XRD data's background was carried with using the Sonneveld-Visser algorithm. Peak of (111), (220), (311), (422), (511), (400) is detected. $ZGO:Eu^{3+}$ thin film also has a spinel structure.

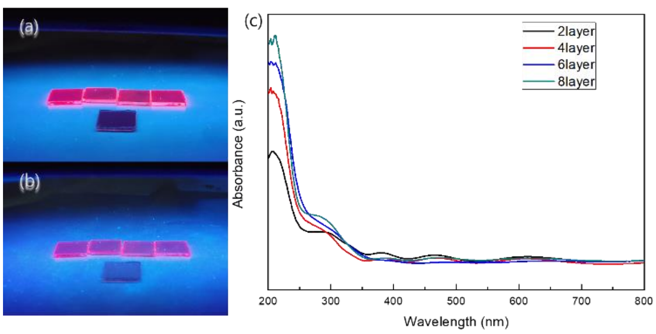

Figure 3. Luminescence of $ZGO:Eu^{3+}$ down-converting film at (a) 254nm and (b) 302nm. (c) Absorption of $ZGO:Eu^{3+}$ film according to coating times.

Fabricated ZGO:Eu3+ film has strong red emitting at 254nm and weak red emitting at 302nm radiation. Figure 3. (c) indicates ZGO:Eu3+ film absorbs well when irradiating light of 200 ~ 250nm region, shows high photoluminescence efficiency, does not absorb well in the region of 250nm ~ 300nm, and shows low photoluminescence efficiency. It shows that the light of 300 to 800 nm in which the perovskite operates is hardly absorbed and the down-shifting layer may not show a significant decrease in efficiency. ZGO:Eu3+ film adapted perovskite solar cell can also be used as a deep-uv detector that can distinguish deep or shallow at 250nm with adding ~300nm short-pass filter.

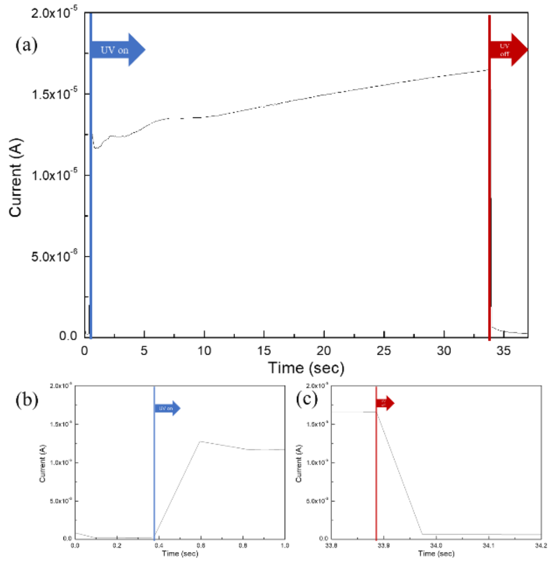

Figure 4. I-T Curve of ZGO:Eu^{3+} applied perovskite solar cell with 254nm irradiation.

The ultraviolet light was down-converted through the ZGO: eu film to reach the perovskite and an additional current of about 15 uA was generated. After about 0.2 seconds of UV irradiation, steady state was reached and the generated current gradually increased for 34 seconds. It returned to its initial state in 0.8 seconds after UV irradiation, which means that it can be operated sufficiently as an UV light sensor.

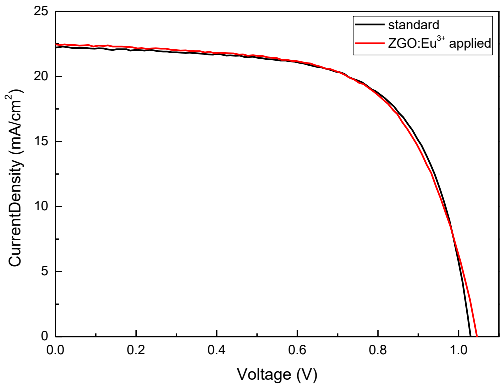

Figure 5. I-V Curve of ZGO:Eu^{3+} applied perovskite solar cell and standard perovskite solar cell under 1sun.

As can be seen in the Figure 5, although the amount of current of the solar cell using ZGO is slightly reduced, it has no significant effect on the efficiency.

3. Conclusions

The ZGO: Eu^{3+} film was successfully fabricated and confirmed to have a UV down conversion. The down-converted light was absorbed in the perovskite, transformed into an electrical signal, and UV sensing was confirmed. It has been found that there is no problem in the efficiency of the solar cell because it absorbs almost no visible light.

Acknowledgement
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