電気化学法による $Cu_2O/\alpha-Fe_2O_3$ ヘテロ接合太陽電池の作製

Fabrication of Electrodeposited Cu_2O/α-Fe_2O_3 Heterojunction Solar Cells

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Copper oxide (Cu_2O) and iron oxide (α-Fe_2O_3) have attracted lots of interest for their semiconducting characteristics, and they have been studied for wide range of applications such as solar cells, photoanodes, etc. Additionally, Cu_2O can be deposited by employing electrodeposition technique which has been a new way for the fabrication of thin film semiconductors, and α-Fe_2O_3 can be easily made by annealing of iron oxide hydroxides (γ-FeOOH). In this study, α-Fe_2O_3 thin film is utilized as a potential n-type material to fabricate p-n heterojunction, and the photovoltaic properties of Cu_2O/α-Fe_2O_3 heterojunction are evaluated and investigated. Recently successful fabrication of Cu_2O/FeOOH p-n junction has been reported,[1] but as far as we know, fabrication of Cu_2O/α-Fe_2O_3 p-n junction has not yet been tried. Hence, this study has a possibility of offering new candidate materials in solar cell fabrications.

Prior to the fabrication of the Cu_2O/α-Fe_2O_3 structure, the α-Fe_2O_3 film was made by performing annealing on the γ-FeOOH(as-depo) thin film at 400°C for 1 hour, and the γ-FeOOH thin film was electrodeposited onto the ITO substrate at -0.9 (V vs SCE) from oxygen-bubbled 0.05 M $FeSO_4$-0.1 M Na_2SO_4 aqueous solution at room temperature and under stirred condition.[2] The α-Fe_2O_3 film showed n-type conductivity with a band gap of~ 2.1eV. The Cu_2O layer was then galvanostatically electrodeposited on the as-prepared α-Fe_2O_3 thin film from 0.2 M $CuSO_4$-1.6 M lactic acid solution at pH = 12.5 (adjusted by KOH) and solution temperature of 40°C.

Figure 1 shows the Raman spectrum of the annealed sample with the measured typical Raman characteristics of commercial α-Fe_2O_3 powder as standard. As shown in figure 2, the Cu_2O/α-Fe_2O_3 and Cu_2O/γ-FeOOH(as-depo) heterojunctions both exhibit rectifying properties and photovoltaic characteristics. The best values of the Cu_2O/α-Fe_2O_3 heterojunction solar cell parameters are V_{OC} = 0.038 V and J_{SC} = 1.12 mA/cm^2, which are not significantly different from those of the Cu_2O/γ-FeOOH heterojunction. According to these results, there is no obvious difference between α-Fe_2O_3 and γ-FeOOH when they are applied as an n-type material to fabricate p-n heterojunction solar cells.

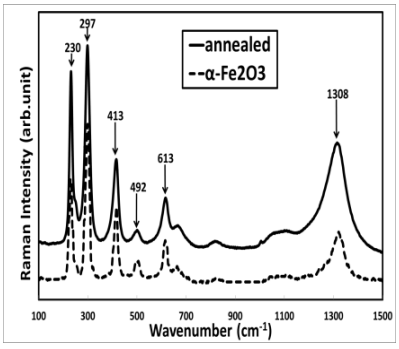

Figure.1 Raman spectra of the annealed sample and commercial α-Fe_2O_3 powder.

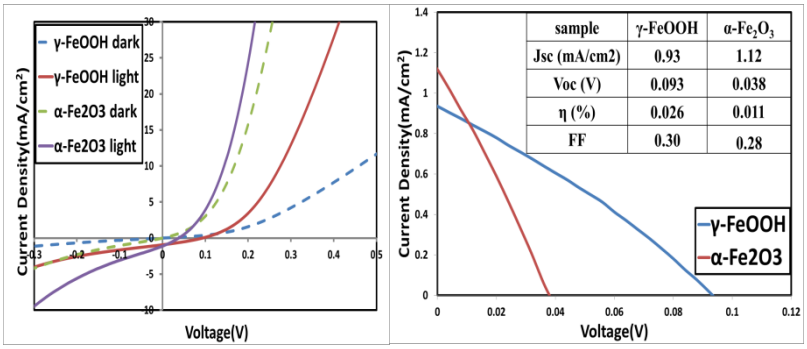

Figure.2 I-V characteristics and photovoltaic properties of the Cu_2O/α-Fe_2O_3(400°C) and Cu_2O/γ-FeOOH(as-depo) heterojunctions.

References

1) J. J. M. Vequizo and M. Ichimura, Appl. Phys. Express 7, 045501 (2014).

2) J. J. M. Vequizo and M. Ichimura, Appl. Phys. Express 6, 125501 (2013).

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