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明志科技大學
Ming Chi University of Technology

大學部
實習成果觀摩競賽

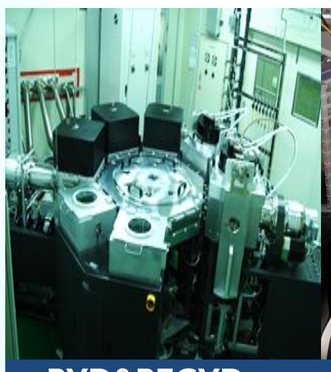
專業主題

W-doped In_2O_3 transparent conductive oxide for Heterojunction Silicon solar cells

內容摘要

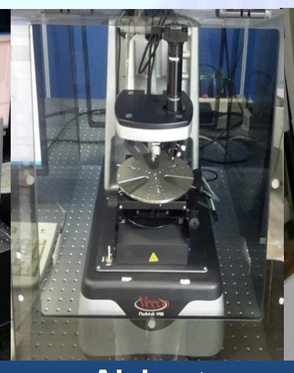
The highly transparent W-doped In_2O_3 (IWO) films was deposited by magnetron-sputtering and investigate the influence of DC powers and temperatures for heterojunction silicon (HJT) solar cells. The DC power changed from 400W to 600W and the temperature range is 25 to 200 ℃. The XRD results showed the films have entirely amorphous structure and the average transmittance over 85% in the visible range. It was found that the IWO film deposited at 400W and 100℃ showed the lowest resistivity of 5.6×10^{-4} Ω-cm and the highest visible transmittance of 89% at 200℃. Then 2x2 cm^2 HJT solar cells were fabricated and the best efficiency reached 20.54% under 400W and 200℃.

實驗儀器

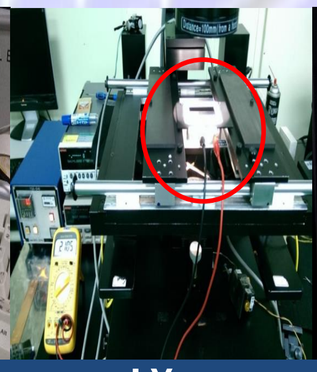

PVD&PECVD


Four point probe


UV Spectrophotometer


Alpha step


Hall effect


I-V curve


Quantum Efficiency

EXPERIMENTAL

IWO thin films were deposited on glass substrates from IWO target by using the DC magnetron sputtering technique. The sputter IWO target was composed of 97 wt.% In_2O_3 and 3 wt.% WO_3 with 99.99% purity. High-purity Ar and O_2 gases were introduced into the chamber and the pressure was kept constant at around 2×10^{-3} torr during the deposition process. The DC power was varied from 400 to 600 W and the temperature range is 25 to 200 ℃. The total thickness of IWO layer was fixed to be 120 nm for each sample.

RESULT AND DISCUSSION

Temperature(℃)	DC	600%(nm)	Thickness(nm)	Resistivity(10^{-4} Ω-cm)
25	400	86.915	138.57	6.037
25	500	83.583	150.56	8.005
25	600	80.429	131.27	9.634
100	400	87.313	137.79	5.616
100	500	85.049	140.17	6.648
100	600	80.007	136.83	10.07
200	400	89.042	125.97	5.834
200	500	85.967	132.55	6.186
200	600	83.286	146.57	8.182

Table.1 The lowest resistivity of 5.6×10^{-4} Ω-cm was obtained by process temperature 100 ℃ and 400W.

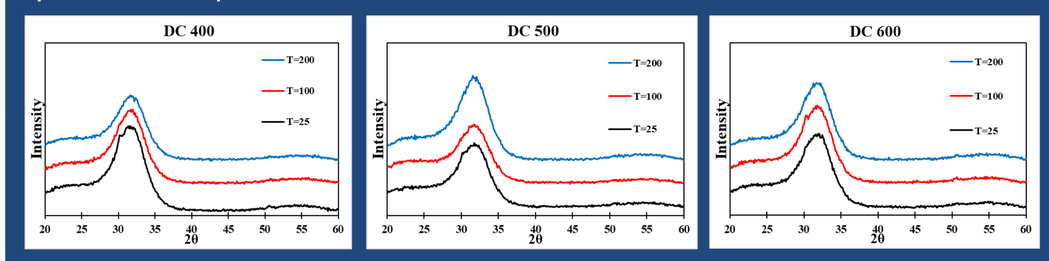


Fig.1 The XRD results showed the IWO films have entirely amorphous structure with various deposition temperature and power.

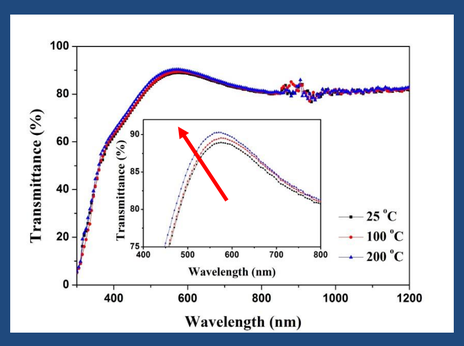


Fig.2 The optical transmittance spectra shows that the transparency were increased by the temperature. **The highest visible transmittance of 89%.**

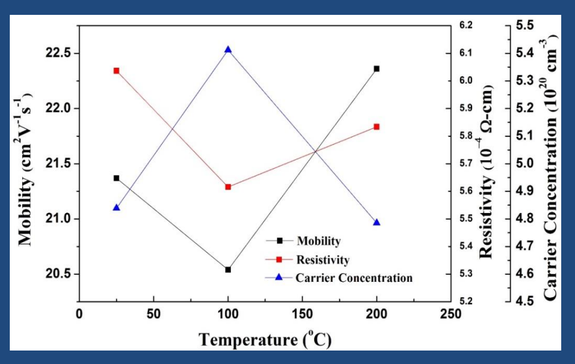


Fig.3 The carrier mobility of IWO films increases from **20.5 to 22.4 $cm^2V^{-1}s^{-1}$** as the temperature increases from 25 to 200 ℃.

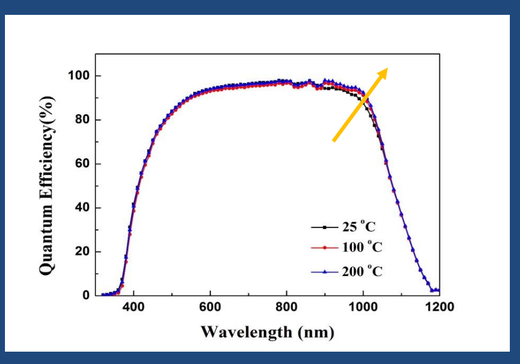


Fig.4 The quantum efficiency (QE) shows that the temperature of 200℃ observed the highest quantum efficiency.

Temperature(℃)	Voc(mV)	Jsc(mA/cm^2)	F.F.(%)	η(%)
25	620	37.1	80.99	18.64
100	648	38.27	82.43	20.45
200	672	38.85	78.69	20.54

Table.2 IV-curve performance of HJT solar cells for various deposition temperature and the best efficiency can be reached **20.54%.**

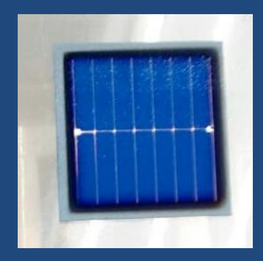


Fig.5 The (HJT) silicon solar cell.

Conclusion

- IWO film deposited at 400W and 200 ℃ shows the lowest resistivity of 5.6×10^{-4} Ω-cm.
- Highest visible transmittance of 89%.
- Carrier mobility of IWO thin film increases from 20.5 to 22.4 $cm^2V^{-1}s^{-1}$.
- 2x2cm HJT solar cells were fabricated with the optimized IWO film and its best efficiency reaches 20.54% under 400W and 200 ℃.

材料工程

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