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Novel Application of MgF_2 as a Back Reflector for Silicon Thin Film Solar Cells

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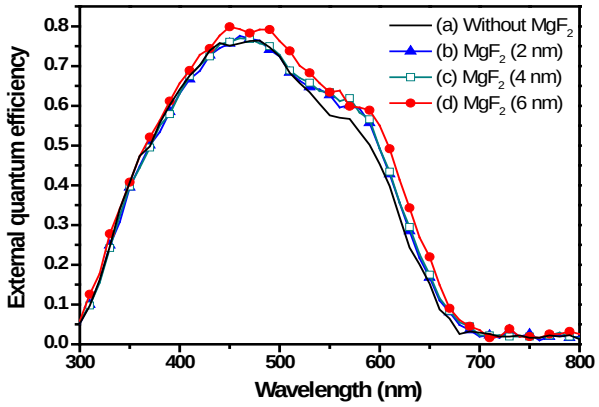
Recently, n-type nanocrystalline silicon oxide (n-nc-SiO_x:H) has been developed, which can replace n-a-Si:H/ZnO double layer by the n-nc-SiO_x:H since it has low index similar to the ZnO. Material with further low index can enhance the back reflection by decreasing parasitic absorption loss in Ag back contact. However, there was no suitable conducting material with low index below 1.9. In area of a-Si:H/c-Si hetero-junction solar cells, MgF_2 layer of 300-400 nm thick is firstly tried as back reflector (BR) between ITO and Ag back reflector (BR) by using a fine shadow mask to make vertical contact between ITO and Ag. [1] In this work, we suggest very thin MgF_2 as a BR between n- n-nc-SiO_x:H and Ag for a-SiO_x:H solar cells without any additional shadow mask for the MgF_2 deposition.

The p-i-n a-SiO_x:H solar cells has been deposited at low temperature of 100 °C by using VHF PECVD system. After depositing the p-i-n films, and following MgF_2 BR was deposited by magnetron sputtering with the MgF_2 target at the deposition rate of 0.03nm/sec. The following solar cell properties have been analyzed after fabricating the cell structure of <Asahi VU/ZnO:Al/p-a-SiO:H (10 nm)/i-a-SiO_x:H (100 nm)/ n-nc-SiO_x:H (30 nm)/ with and without MgF_2 (2-6 nm)/Ag/Al>.

Figure 1 shows enhancement of the absorption by increasing the thickness of BR, which boosted the Jsc from 9.60 to 10.76 mA/cm^2. Before forming complete layer of MgF_2, we found that island-like deposition the BR could allow for carrier collection, and the J_{sc} improvement can be achieved (9.60 to 10.30 mA/cm^2) without significant loss of FF with few nanometer (~4 nm) thick MgF_2 BR.



	(a)	(b)	(c)	(d)
Jsc (mA/cm^2)	9.60	10.18	10.30	10.76
Voc (V)	1.011	1.019	1.015	1.014
FF	0.740	0.734	0.733	0.678
Rs (Ω·cm^2)	7.9	8.1	8.8	13.4
Efficiency (%)	7.18	7.61	7.66	7.40

Fig. 1. External quantum efficiency and performances of fabricated a-SiO_x:H single junction solar cells with the suggested MgF_2 BR with different thickness.

[1] Z. C. Holman, A. Descoeudres, S. De Wolf, and C. Ballif, *Photovoltaics, IEEE Journal of*, vol. 3, pp. 1243-1249, 2013.