Thin film silicon solar cells prepared at low deposition temperatures on transparent flexible substrates

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Advantages of flexible solar cells

- High throughput by roll-to-roll fabrication
- Use of low cost transparent plastic possible
- Integration in various shapes and sizes
- Lightweight
- Compatible with known thin-film silicon technologies

Motivation

Post deposition annealing (at 140°C) of low temperature a-Si:H solar cells

Effects of a-Si:H layer temperature on annealing behaviour

Table: Sample | T_p-layer [°C] | T_n-layer [°C] | T_m-layer [°C]
--- | --- | --- | ---
A | 140 | 140 | 140
B | 200 | 140 | 140
C | 200 | 140 | 200

Results: low temperature solar cells on glass substrates

Performance of low temperature thin-film silicon solar cells can be improved by post deposition annealing treatment and reduced sheet resistance of the TCO

Reasons for the improvement in solar cell performance upon annealing need to be further investigated in detail

ZnO/Ag/ZnO layer stacks show promising electrical and optical properties as well as fill factor, but the thin Ag interlayer causes losses in short circuit current density

PET (Polyethylene terephthalate): very low cost, but temperature sensitive

Optimized low temperature (140°C) solar cells are needed

Different TCOs on foil substrates

ZnO/Ag/ZnO layer stack shows best electrical and optical properties

Solar cells

Losses in EQE because of higher reflectance for ZnO/Ag/ZnO layer stack

Simulations (K. Ding) confirm that introduction of thin Ag layer increases reflectance of the solar cell

Results: TCO development on foil substrates

Simulations (K. Ding) confirm that introduction of thin Ag layer increases reflectance of the solar cell

No difference upon annealing between cells with p-layers at 140°C (A) and 200°C (B)

Cell with high temperature n-layer shows best performance nearly from the beginning (C)

Possible reasons: dopant activation, defect healing, hydrogen diffusion, diffusion at interfaces, …

Conclusions

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ZnO/Ag/ZnO layer stacks show promising electrical and optical properties as well as fill factor, but the thin Ag interlayer causes losses in short circuit current density

Publications:
K. Wilken, V. Smirnov et al, 40th IEEE Photovoltaic Specialists Conference (PVSC-40), Denver, USA, June 2014

Projects:
FlexSol (0325442D)