Introduction

Potential-induced degradation
There are several degradation phenomena in mega solar power generation systems. Potential-induced degradation (PID) is identified as one of the most serious degradation modes. The PID of p-type c-Si modules well documented, but that of n-type c-Si is not. Here we investigate the PID of n-type c-Si solar cells. In addition, PID research is required for each cell structure.

N-type rear-emitter c-Si cells

We have reported the PID of n-type c-Si rear emitter cells[1]

One of the advantages of n-type c-Si rear emitter cells: The low-cost fabrication process same as that for p-type front-emitter c-Si cells.

Purpose

Previous results for the PID of n-type rear-emitter cells[1]

- Decrease in Voc
- Decrease in EQE in a short-wavelength region

Activate Surface recombination?

Methods

Sample process flow

- Substrate n-type FZ c-Si (100)
- Resistance: 1-5 Ωcm
- Bulk minority carrier lifetime > 10 ms
- SiNx properties
- Refraction index: 1.98
- Thickness: 75 nm

Structure of rear-emitter c-Si cell

Results & discussion

PID -1000 V

- PID starts to occur after around 20 min.
- Saturation of degradation within around 100h.

PID +1000 V

- Saturation of degradation within 1min.
- Faster degradation than that by negative bias.

Recovery PID -test 1000 → +1000 V

Recovery PID test +1000 → -1000 V

Proposed mechanism for n-type rear-emitter c-Si cells[3]

This degradation is not caused by Na

Na didn’t work as shunt paths because there is no p-layer in our samples. Na in stacking faults merely works as recombination centers.

The model charge SiNx

This degradation is not caused by Na
1. +1000 V introduces electrons into SiNx
2. SiNx is negatively charged.
3. Negatively charged SiNx attracts minority carriers, holes.
4. Holes recombine with majority carriers, electrons, at the c-Si surface.

Conclusions

We observed the activation of surface recombination after the PID tests using both polarities.
- In the case of negative bias, PID occurred perhaps owing to Na in stacking faults.
- In the case of positive bias, PID may be caused by negative fixed charges additionally introduced into SiNx.

References

Acknowledgements
This work was supported by NEDO.