

# The PID delay effect by UV light irradiation for p-type crystalline Si solar modules based on the different refractive indexes of silicon nitride layer

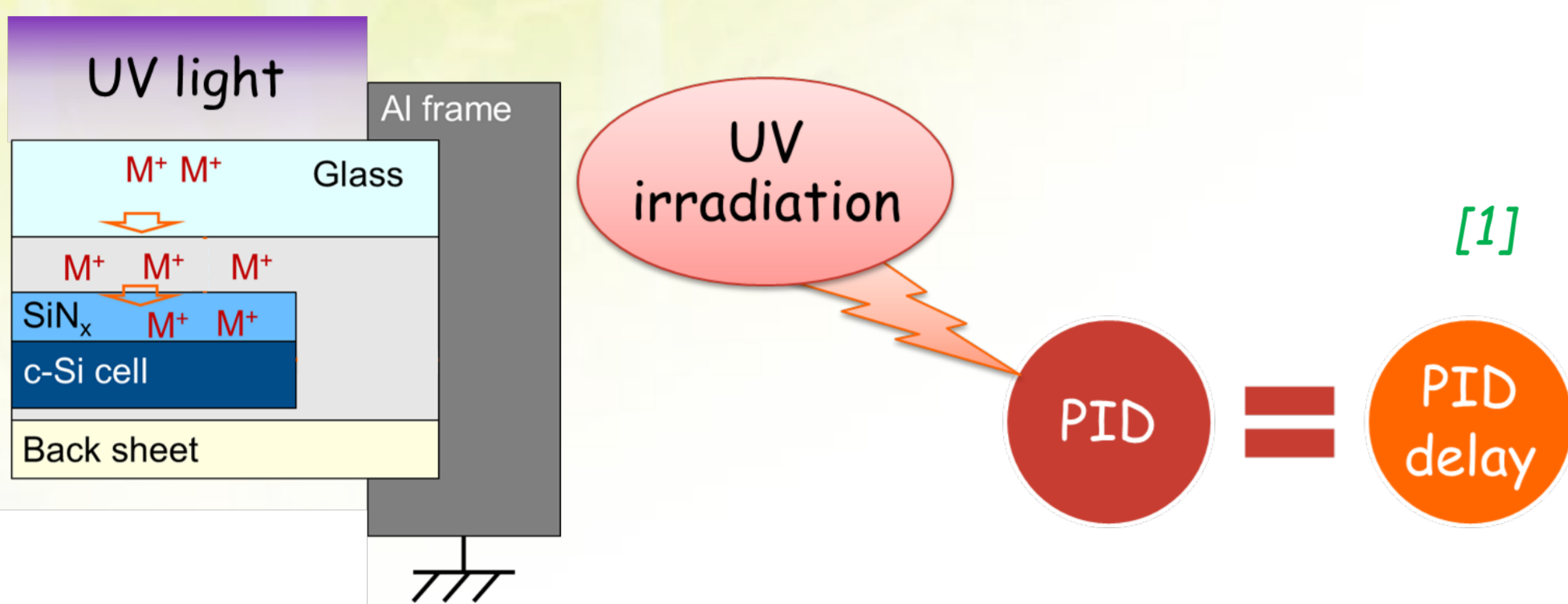
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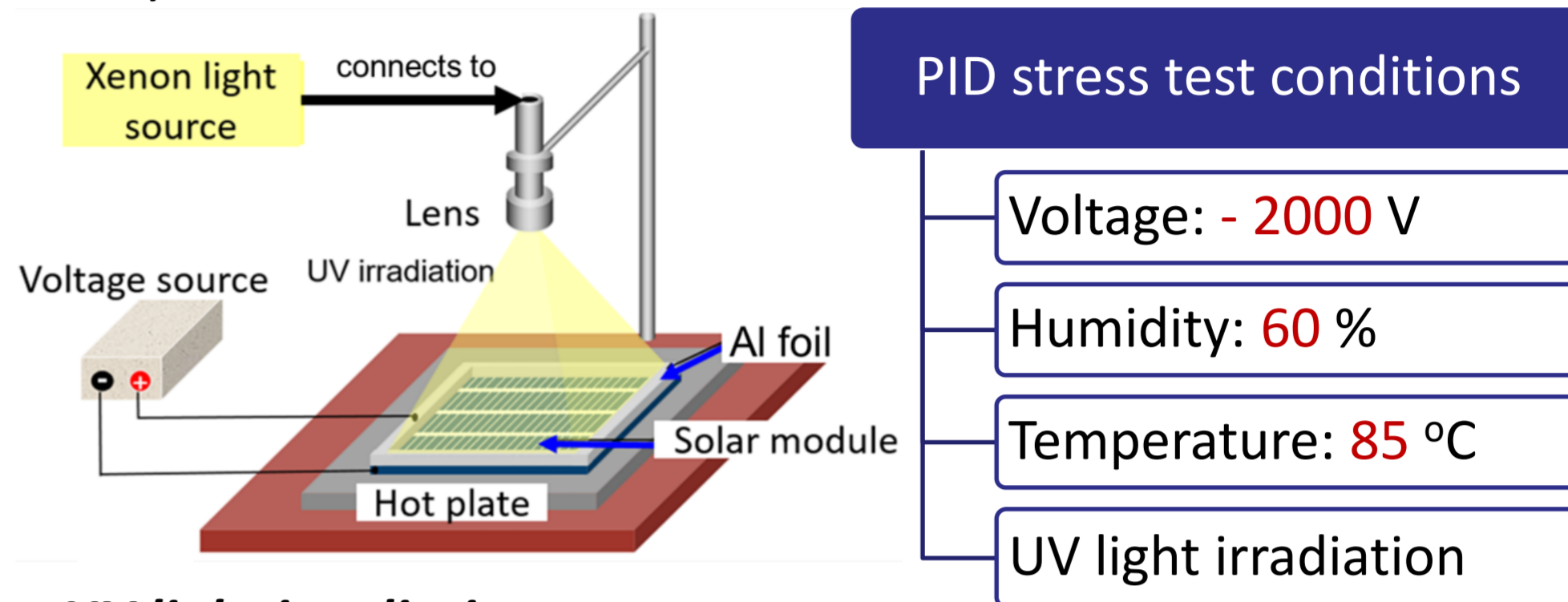
## 1. Motivation



- UV light irradiation causes the increased SiN<sub>x</sub> conductivity of silicon solar cells [2].
- How does the PID delay effect occur in Si solar cells with SiN<sub>x</sub> layers of different refractive indexes?

## 2. Experimental procedure

- Si solar modules with different refractive indexes of SiN<sub>x</sub> layer: 1.95; 2.05 and 2.20.

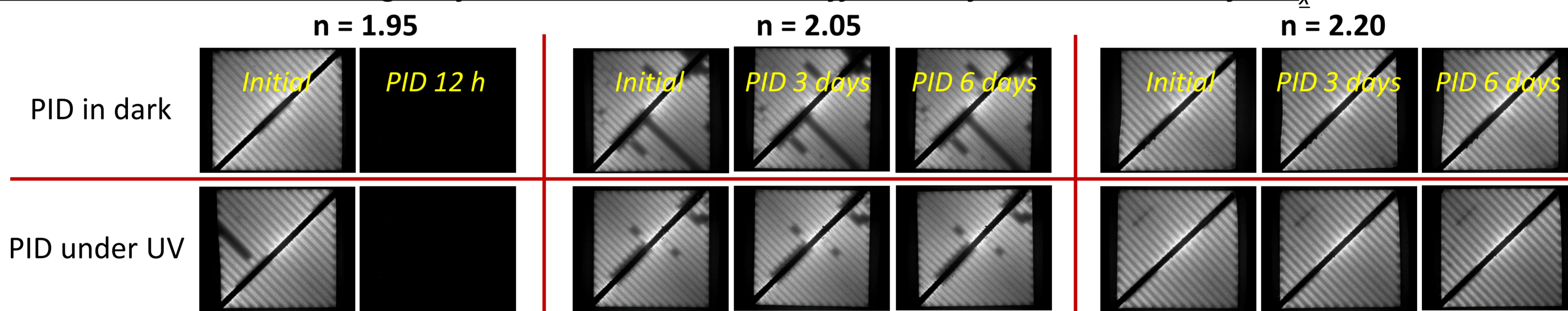


### UV light irradiation:

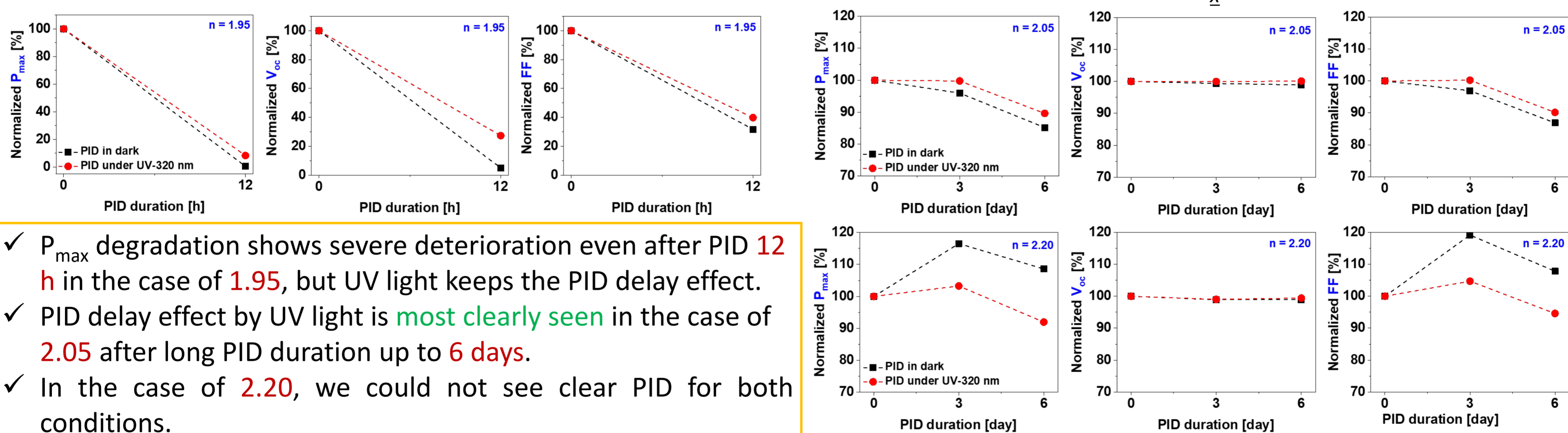
- Wavelength: 320 nm ± 5 nm
- Photon flux density: 1.03 × 10<sup>15</sup> cm<sup>-2</sup>s<sup>-1</sup>

## 3. Results and Discussion

### 3.1. Electroluminescence images of Si solar modules with different refractive indexes of SiN<sub>x</sub>



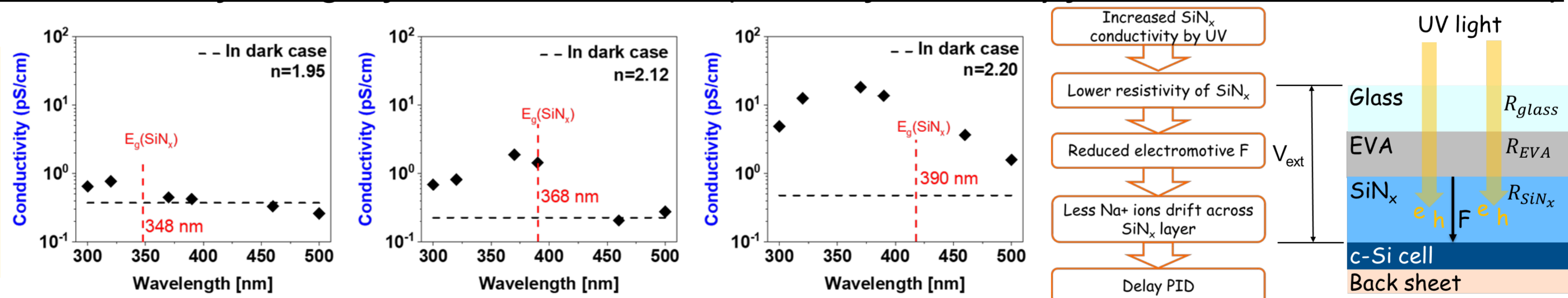
### 3.2. Comparison of Si solar module performances with different refractive indexes of SiN<sub>x</sub>



- P<sub>max</sub> degradation shows severe deterioration even after PID 12 h in the case of 1.95, but UV light keeps the PID delay effect.
- PID delay effect by UV light is most clearly seen in the case of 2.05 after long PID duration up to 6 days.
- In the case of 2.20, we could not see clear PID for both conditions.

### 3.3. PID delay effect mechanism of UV light for Si solar modules (Photon flux density for meas.: 9.26 × 10<sup>14</sup> cm<sup>-2</sup>s<sup>-1</sup>)

The SiN<sub>x</sub> conductivity increases due to UV light absorption which is limited by SiN<sub>x</sub> band gap.



## 4. Conclusions

- Solar cells with the higher SiN<sub>x</sub> refractive index is avoidable from PID phenomenon.
- PID delay effect is most clearly observed in solar cells with a SiN<sub>x</sub> refractive index of 2.05 for long PID duration up to 6 days.
- Conductivity increased by UV light irradiation is responsible for the PID delay effect.

## References

[1] A. Masuda, Y. Hara, *Jpn. J. Appl. Phys.* 57, 08RG13 (2018).  
 [2] D. C. Nguyen et al., *Proc. 46th IEEE Photovoltaic Specialists Conference, Chicago, USA, 2019.*

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