# Potential-induced degradation of the shunting type: on the origin of sodium in shunt paths

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## 1. Introduction

Potential-induced degradation rapidly and significantly affects the photovoltaic (PV) module's performance due to a high potential difference across the PV cell and the grounded module's frame.[1] PID has various types where PID of the shunting type (PID-s) is common within silicon PV cells.[2] Extensive research already points towards sodium (Na) ions as the root cause of the efficiency degradation under PID-s.[3] However, the origin of the Na ions is still under debate. Some publications state that the soda-lime glass (SLG) cover of the PV module is the main source of the Na ions. In contrast, others have proven to degrade solar cells in the absence of an encapsulation material and front cover glass. [3-6]

With this work, we try to find an answer to the current debate and thus find the source of the Na ions causing PID-s.

## 2. Experimental

- 10 samples: 5xA and 5xB
- Foil method
- Climate chamber:
  - 60°C
  - < 60% relative humidity
- 315 hours of HV stress

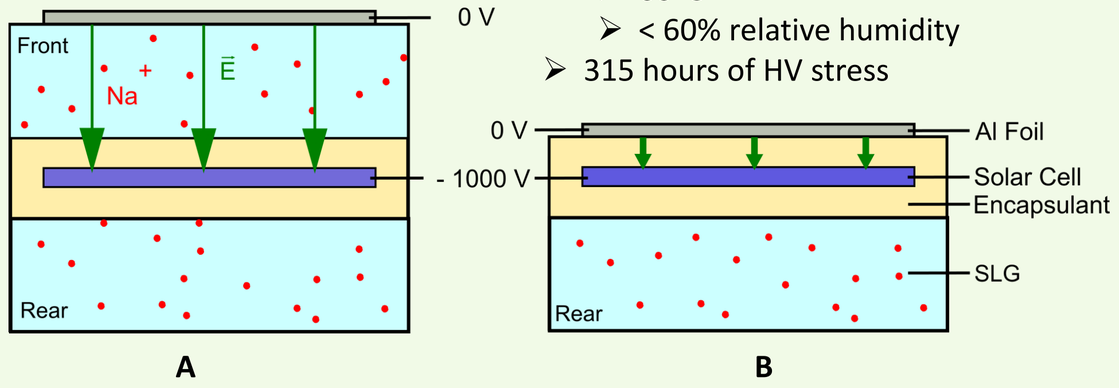


Figure 2: Configuration A laminate using SLG front cover, and configuration B without SLG front cover

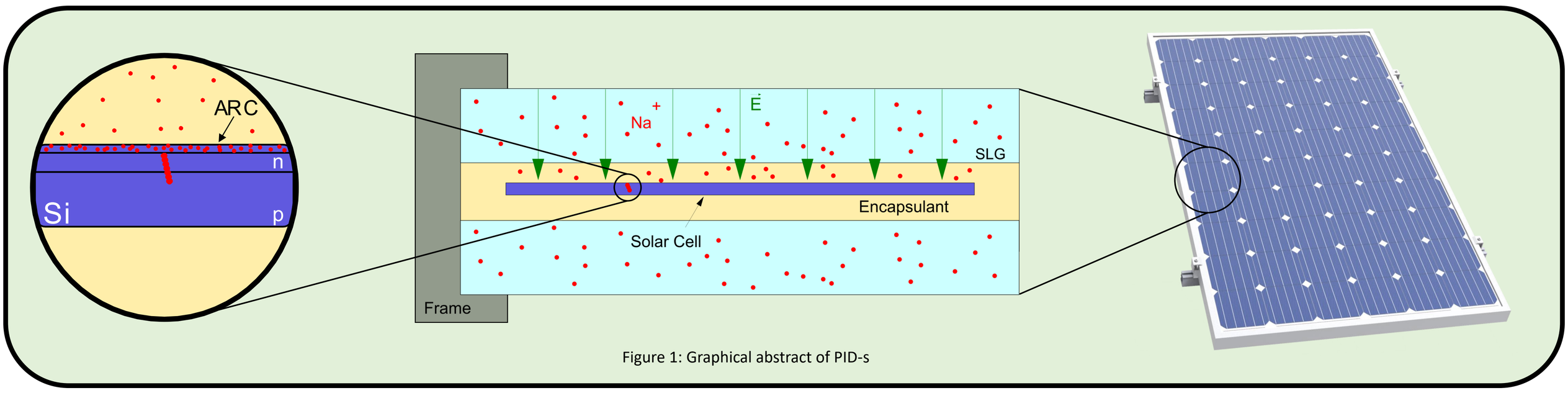


Figure 1: Graphical abstract of PID-s

## 3. Results

Five identical multicrystalline glass/glass configured mini-modules, together with five laminates with the absence of an SLG front cover underwent 315 hours of high-voltage stress under controlled environmental conditions. Figure 3 illustrates the light IV curves of the intermediately measured configuration A and B laminates. It is noticeable that the area beneath the IV curve of the configuration A laminate is significantly affected with increasing stressing time. The decrease in power is mainly attributed to a change of the IV curve's slope near $I_{SC}$. Hence, this means that the laminate's shunt resistance is affected, and the module is experiencing PID of the shunting type. This is in great contrast to the configuration B laminate where no significant changes in $I_{SC}$, $V_{OC}$, or power are noticeable.

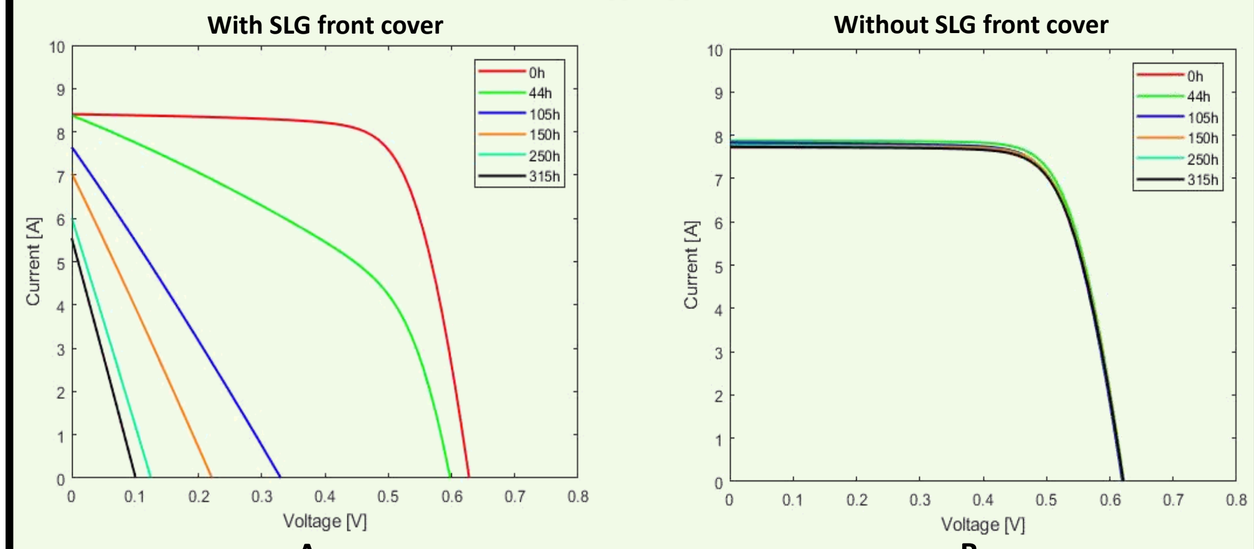


Figure 3: Light IV of configuration A and B laminates

## 4. Conclusion

Extensive research already identified sodium ions as the root cause of the efficiency degradation under PID-s.[3] Although the origin of these ions is still under debate.

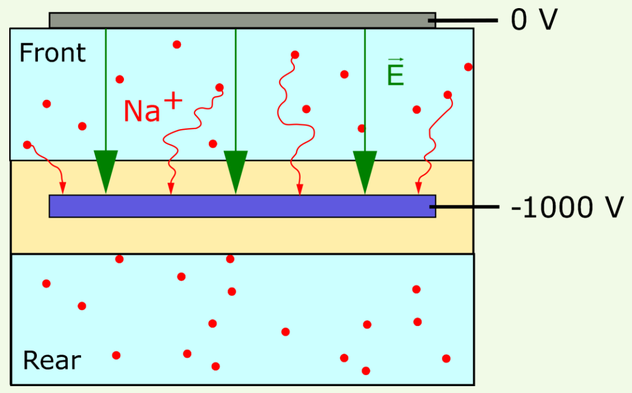


Figure 4: Sodium ion migration from the SLG front cover towards the solar cell under influence of an electric field

From the results acquired with this research, it can be concluded that the SLG front cover behaves as the main supplier for the sodium ions, which are the dominant factor within the PID-s mechanism. This conclusion can be made since only the cells containing an SLG front cover degrade, in contrast to the laminates without SLG front cover.

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