# Shunt Detection in Amorphous-Silicon Modules by I/V-Measurements

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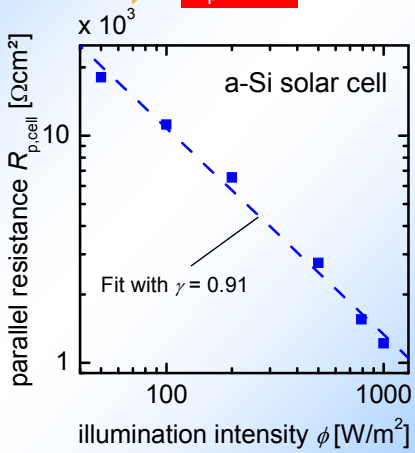
**Goal:** Method to extract parallel resistance of every cell in an encapsulated a-Si module

**Approach:** Measuring and simulating the effect of one shaded cell on the shunt resistance of the module

## Shunt dependence on light intensity

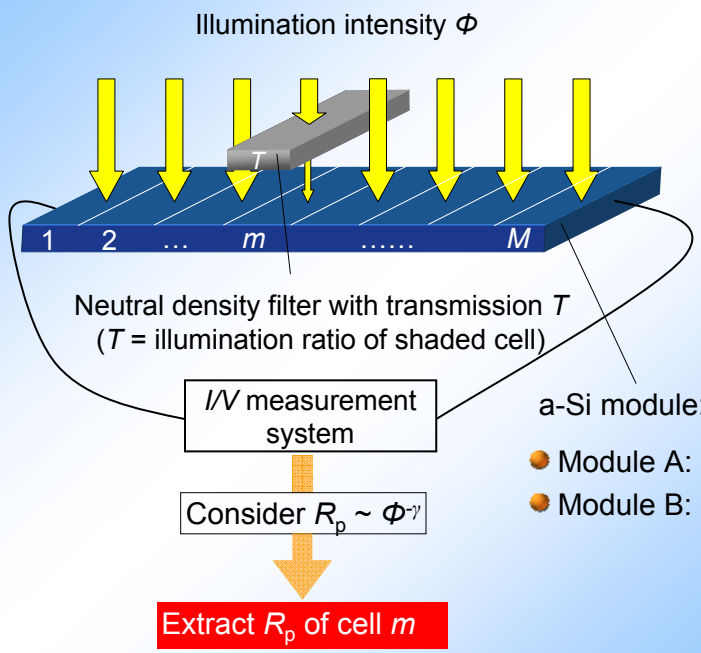
- Photoconductivity of a-Si: $\sigma_{ph} \sim \Phi^{\gamma}$ [1]
  $\gamma$ : Rose factor ($0 \le \gamma < 1$)
- Shunt $R_p$ of a-Si solar cell: $R_p \sim \sigma_{ph}^{-1}$

$\Rightarrow R_p \sim \Phi^{-\gamma}$




[1] D.L. Staebler, C.R. Wronski: Applied Physics Letters **31,** 292 (1977)

## Setup

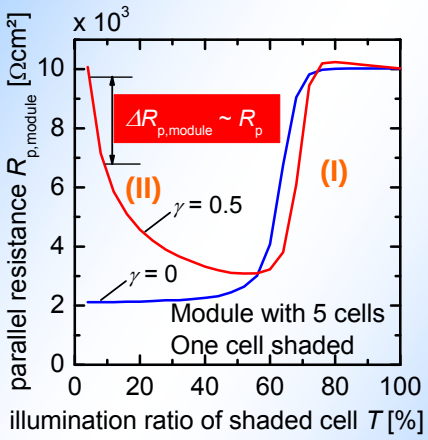



## Simulation of module with shaded cell

Two trends when $T$ decreases:

(I) $R_{p,module}$ decreases

(II) $R_p$ of shaded cell increases ($R_p \sim \Phi^{-\gamma}$)



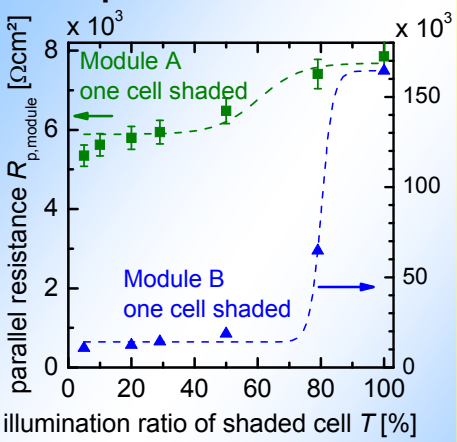

$\Rightarrow R_{p,module}$ increases at low $T$ and $\gamma > 0$

$\Delta R_{p,module} \sim R_p$

$\Rightarrow$ Estimation of $R_p$ of shaded cell

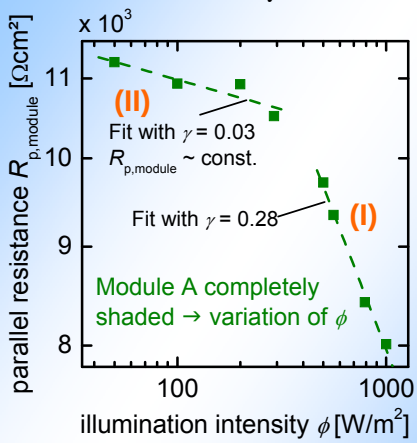
**(Only if $\Delta R_{p,module} > 0$, $\gamma > 0$)**

## Experimental results




- $R_{p,module}$ corresponds to simulation for $\gamma = 0$
- Determination of $R_p$ of shaded cell not possible in this case ($\Delta R_{p,module} = 0$)

## Evidence of $\gamma = 0$




Two ranges for $R_{p,module}$:

(I) $\gamma > 0$ close to $\Phi$ = 1000 W/m² (shunts in a-Si layers)

(II) $\gamma \approx 0$, $R_{p,module} \approx$ const. for low $\Phi$ (e.g. interconnection shunts)

## Conclusions:

- New method extracts $R_p$ of single cells in encapsulated a-Si module
- Applicable if illumination dependent shunts in a-Si layers are dominant
- Limiting factor: "constant" shunts (e.g. interconnection shunts, laser scribing)



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