

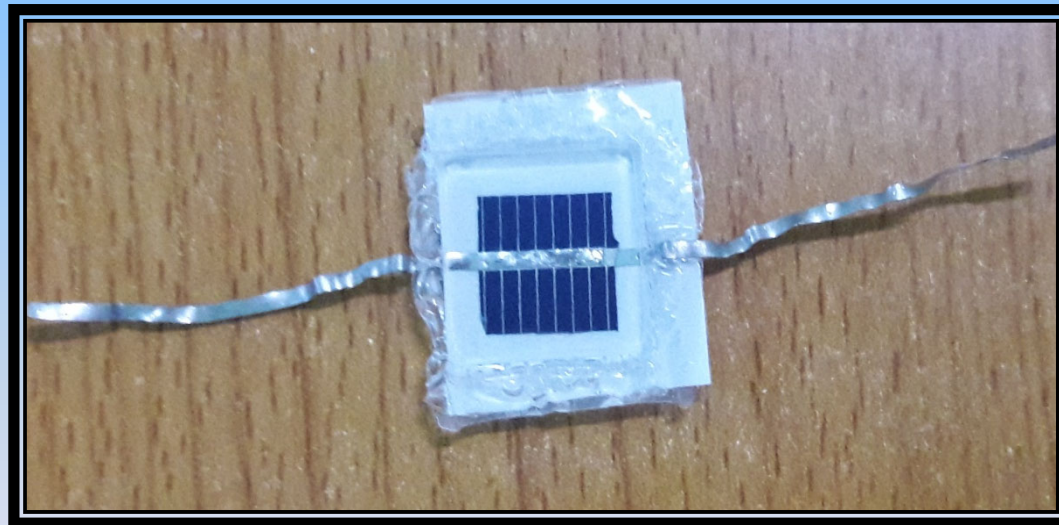
Accelerated Potential-induced Degradation (PID) and Recovery of Small PV Module (Glass/EVA/Cell/EVA/BS)

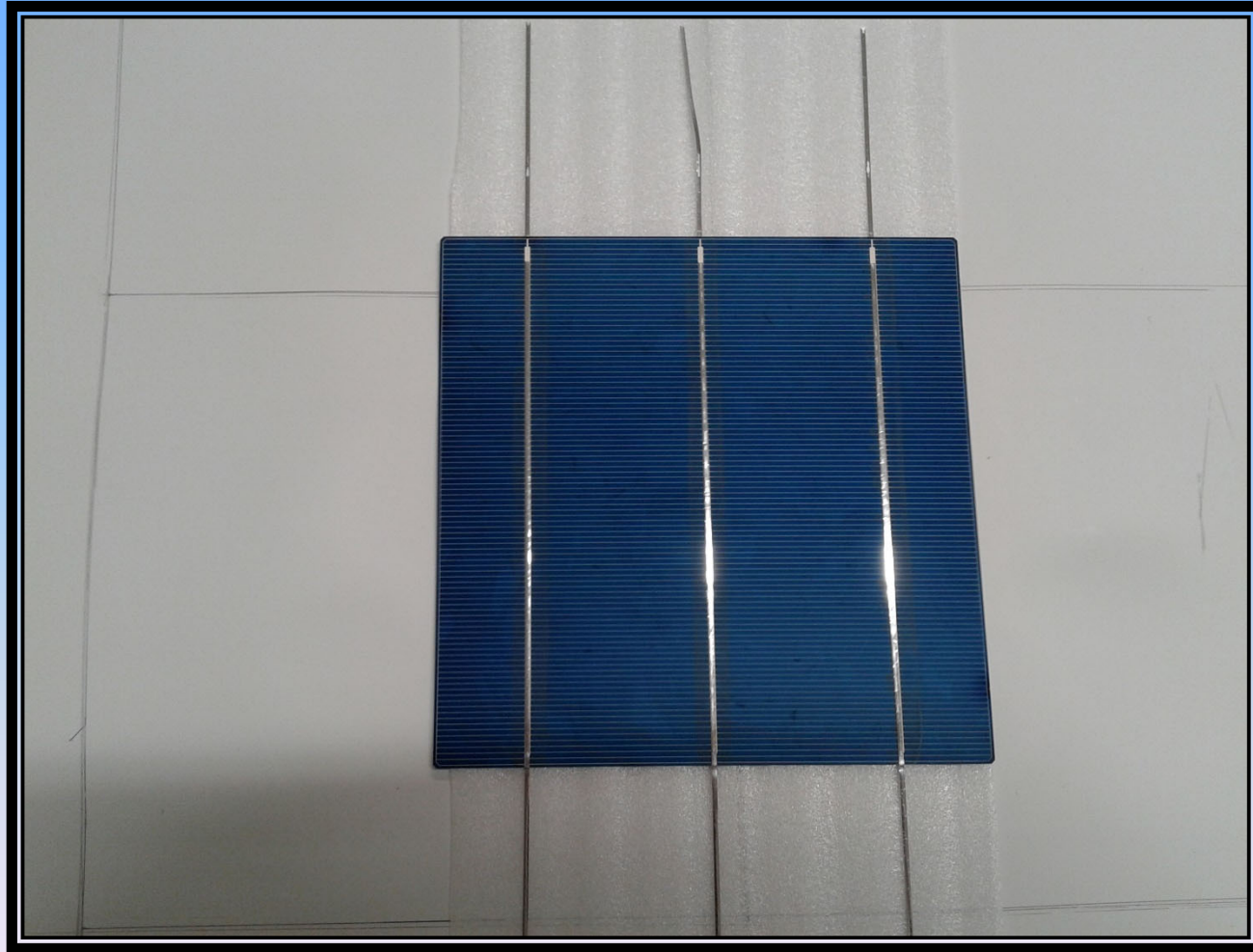
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and Shuichi Nonomura²**

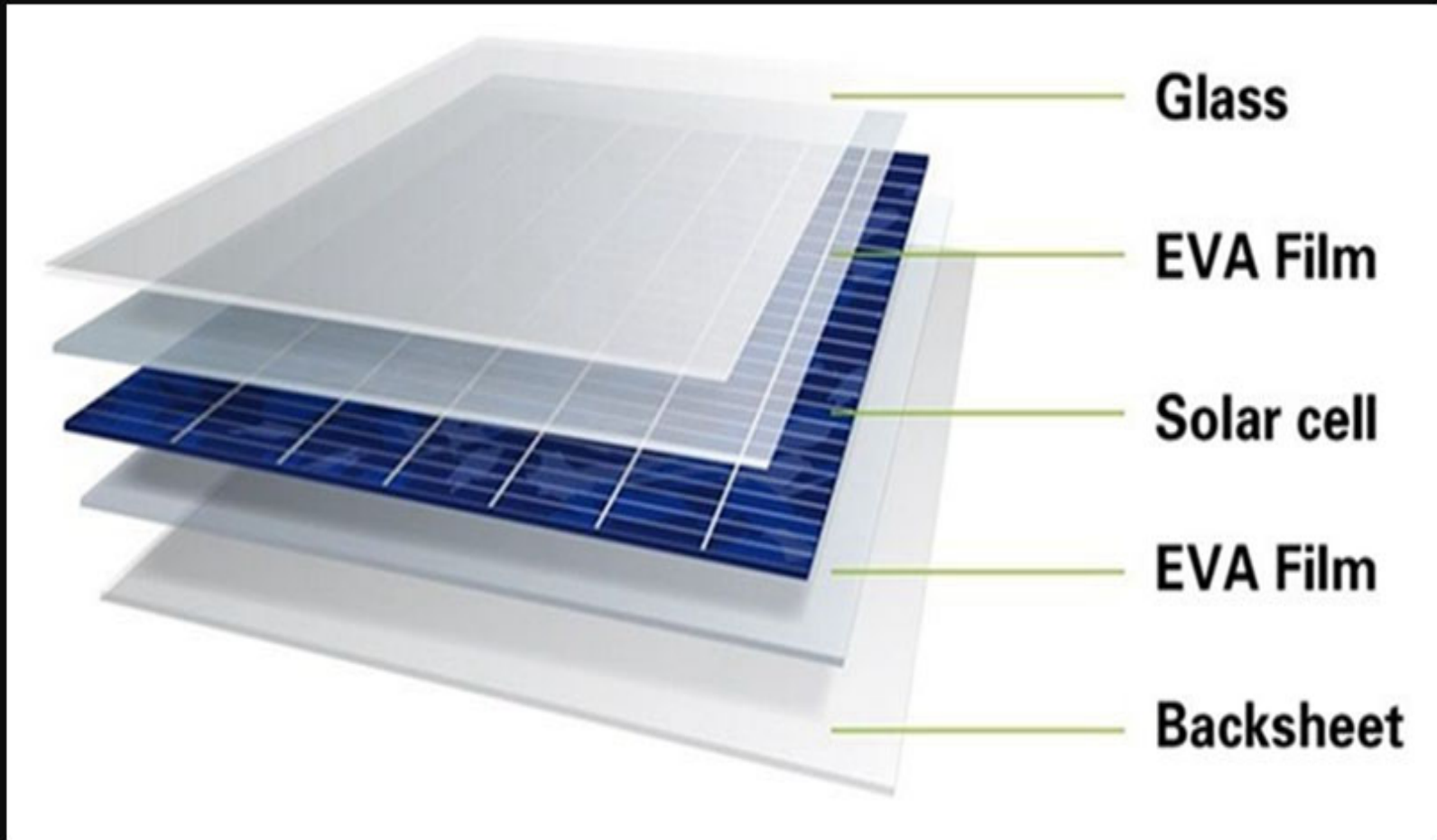
1. Associate Professor, Physics Department, Mandalay University Education
2. Dean of Engineering Faculty, Environmental and Renewable Energy Systems, Gifu University, Japan

MAJOR FOCUS

- Natural & Artificial Recoveries of Accelerated PID in Small Solar Module









LAMINATION TOOL



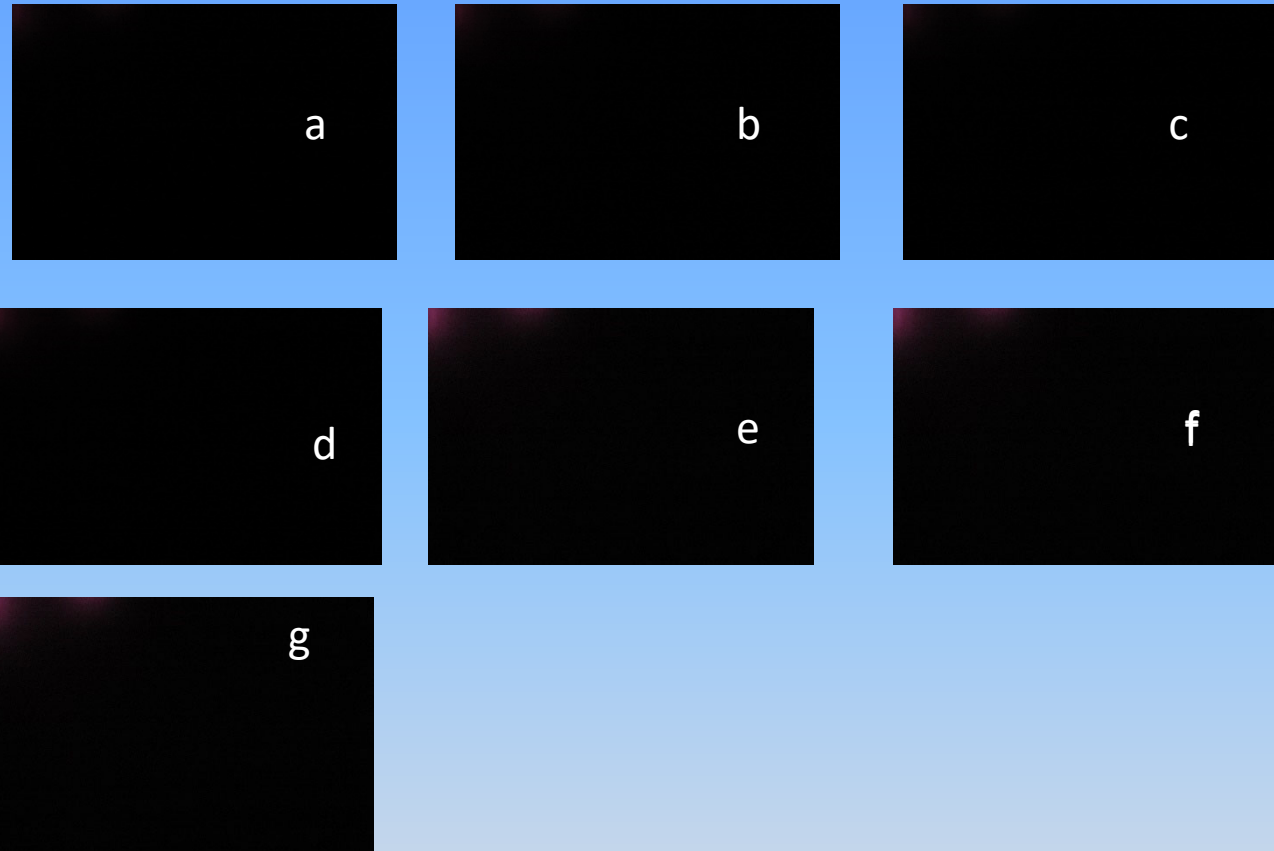
EXPERIMENTAL MENU

	PID	NR	AR1	AR2	AR3	NR1	NR2
Solar Module	-2 kV : 6 h 85°C	★	+2 kV : 3 h 	+2 kV : 3 h 85°C	+2 kV : 3 h 	1 week	1 week

AR = Artificial Recovery
NR = Natural Recovery

EL of SAMPLE at Initial state



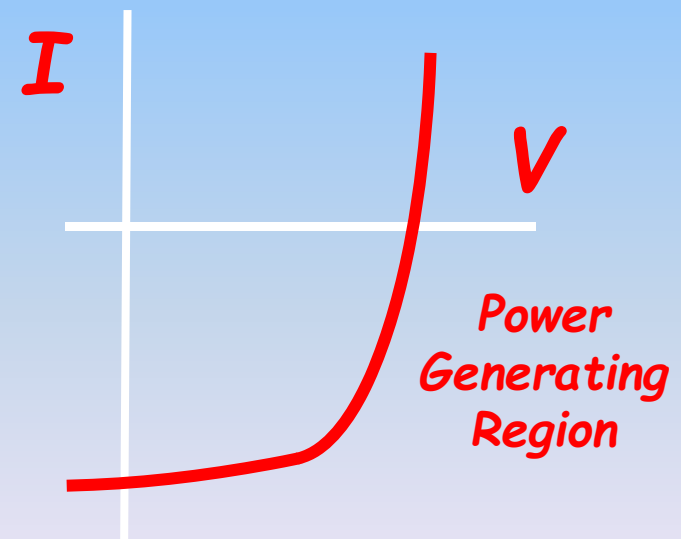
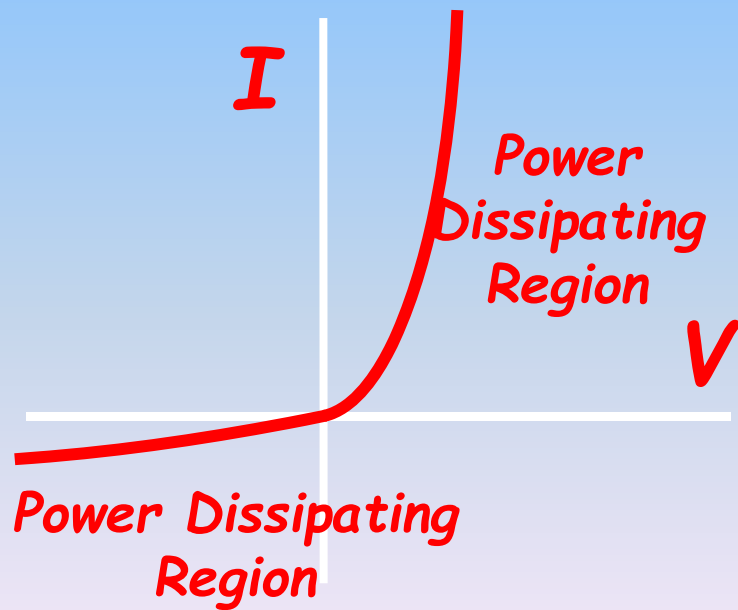
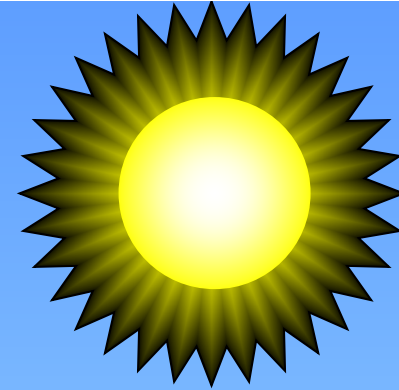


after Degradation/PID (-2kV:6h)(85°C)
(a) at Once (b) 1week later (c) AR 1 (d) AR 2
(e) AR3 (f) NR 1 (g) NR2

EL CAMERA



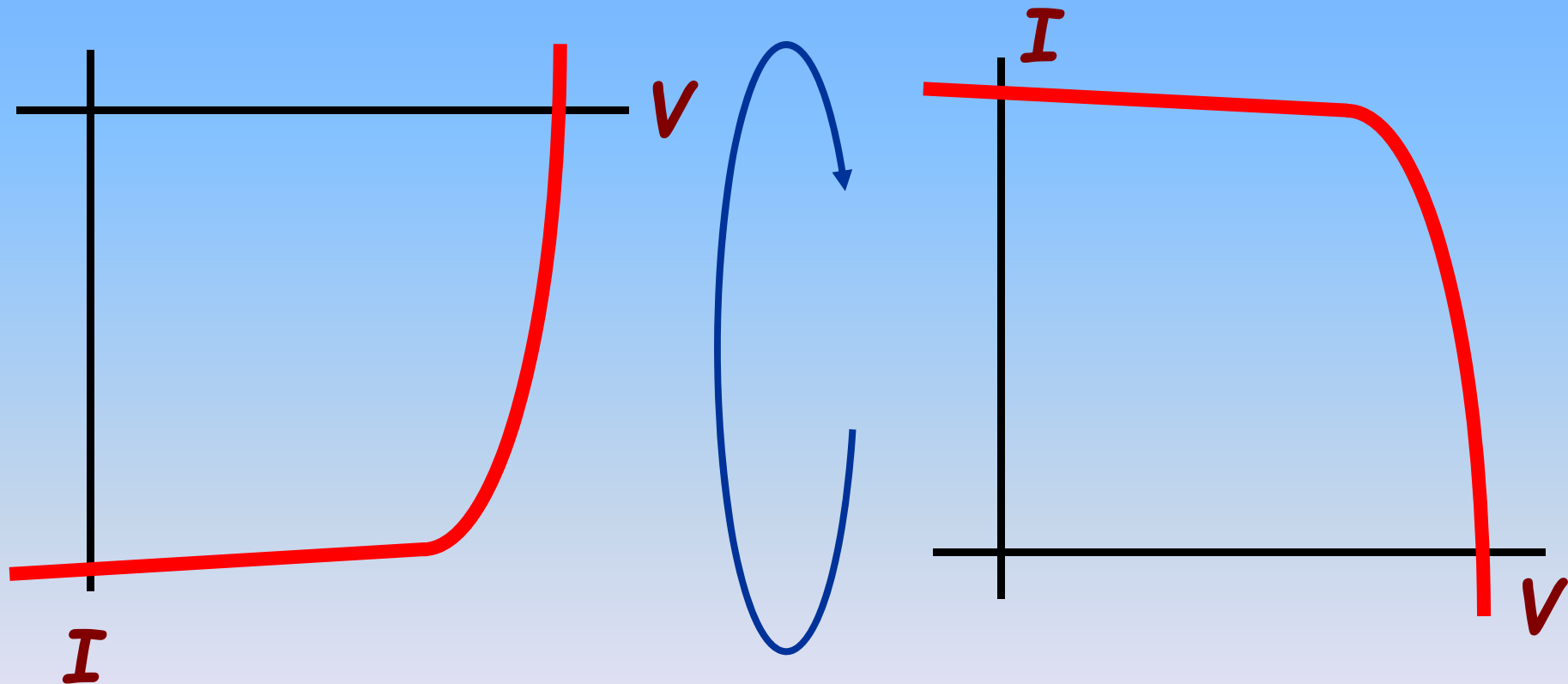
Solar cell characterization



17 Aug 2017 **Dark Characteristic**

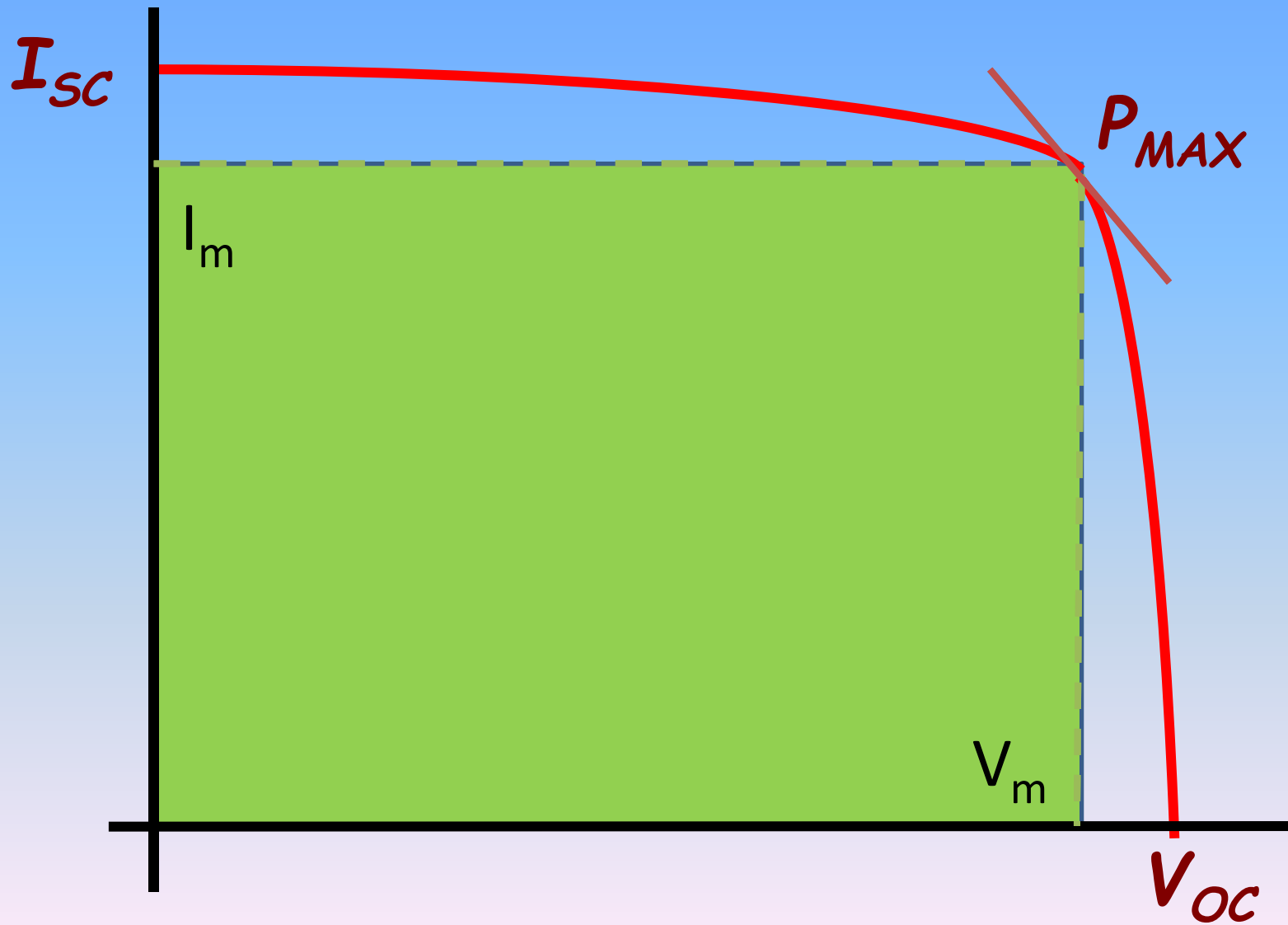
Light Characteristic

The IV characteristic of a solar cell is usually displayed like this:

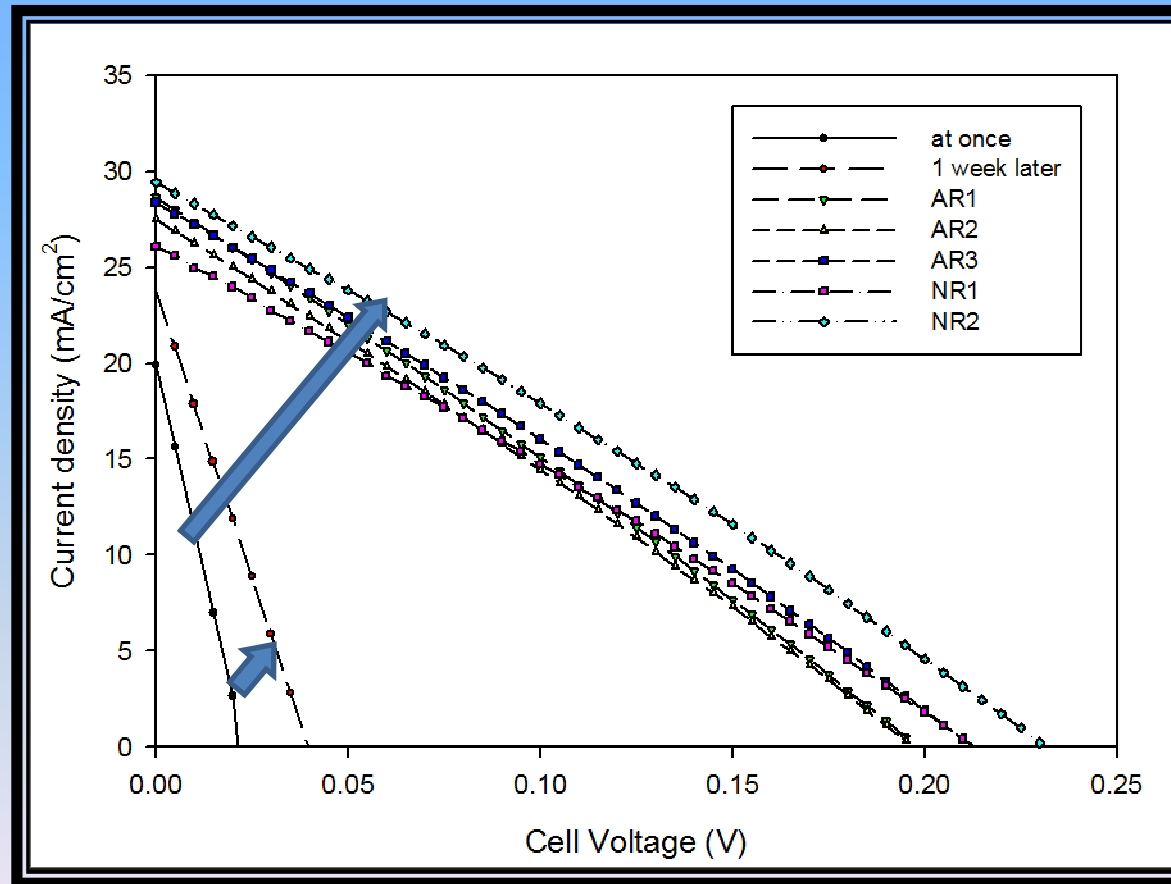


The coordinate system is flipped around the voltage axis.

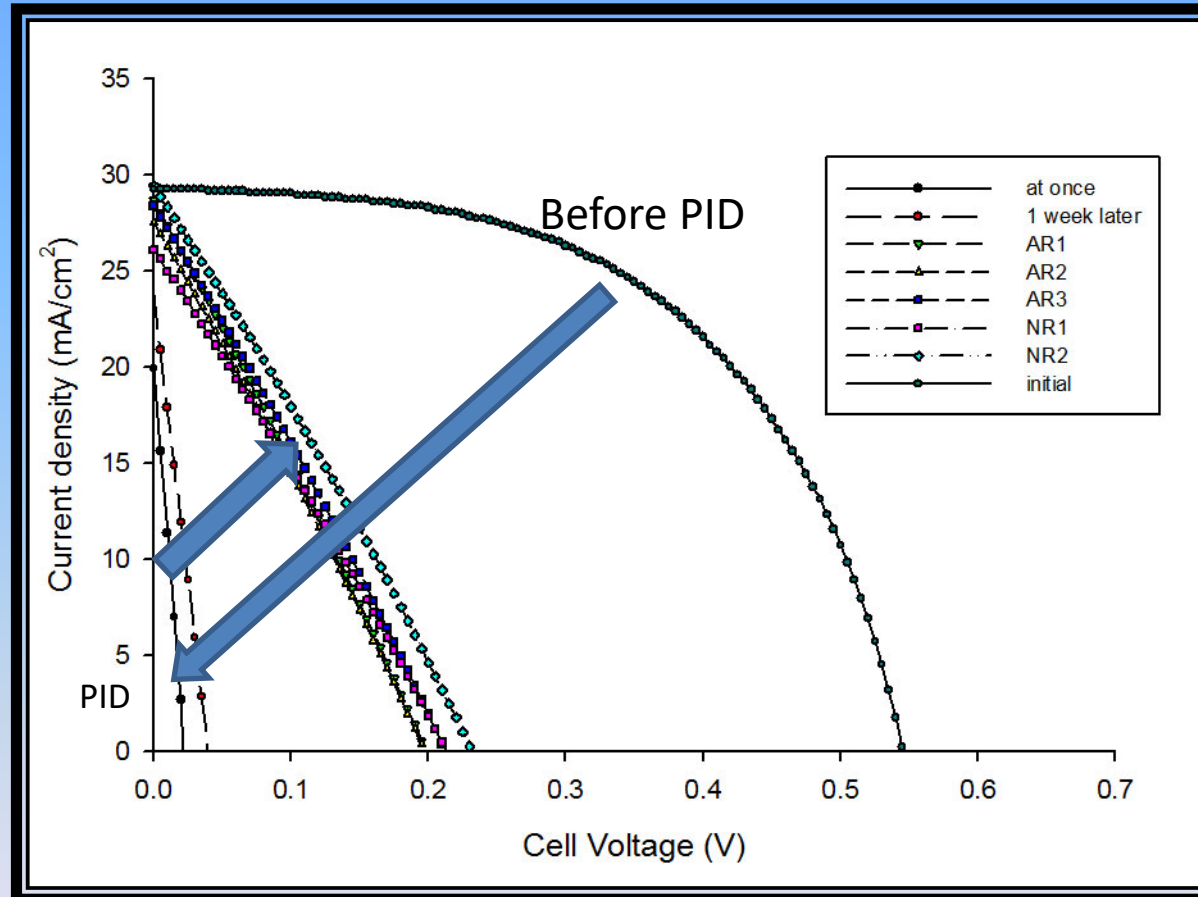
I_{SC} , P_{MAX} , V_{OC}



J-V OF DEGRADATION & RECOVERY

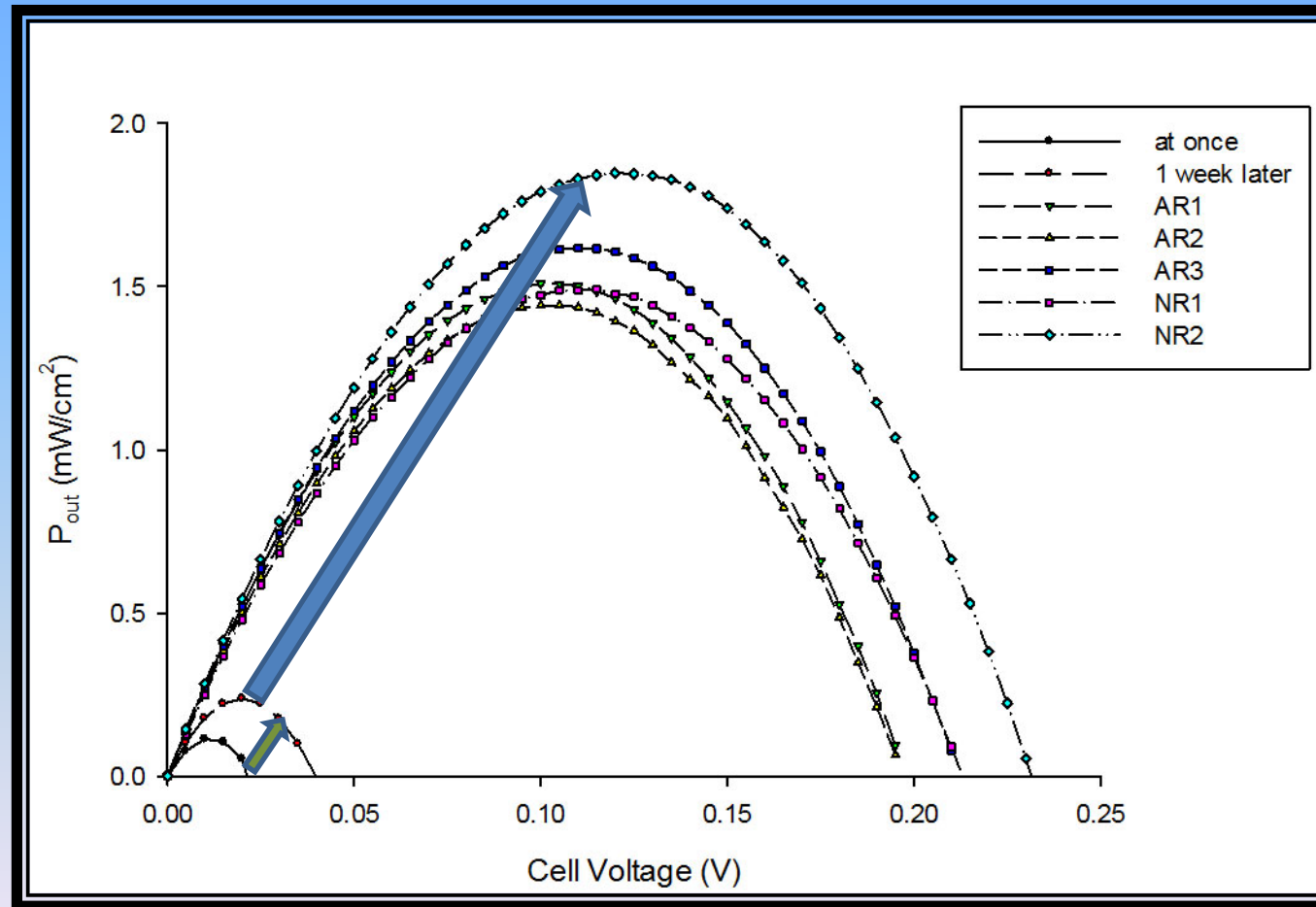


J-V OF INITIAL, DEGRADATION & RECOVERY OF SOLAR MODULE

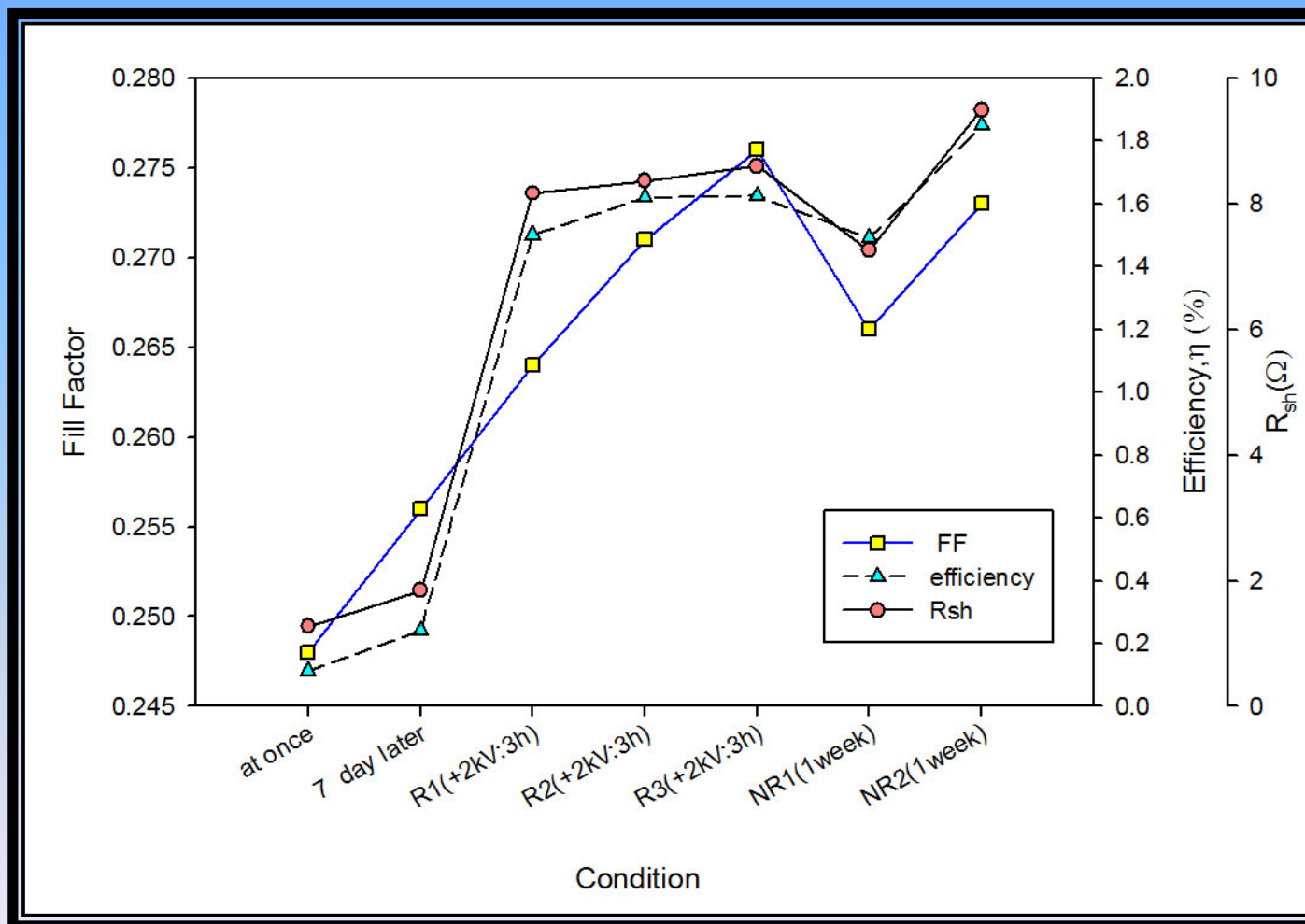


J-V characteristics of small module (0.91cm²) at degradation, artificial & natural recoveries with initial state

P_{out} -V OF DEGRADATION & RECOVERY OF SOLAR MODULE



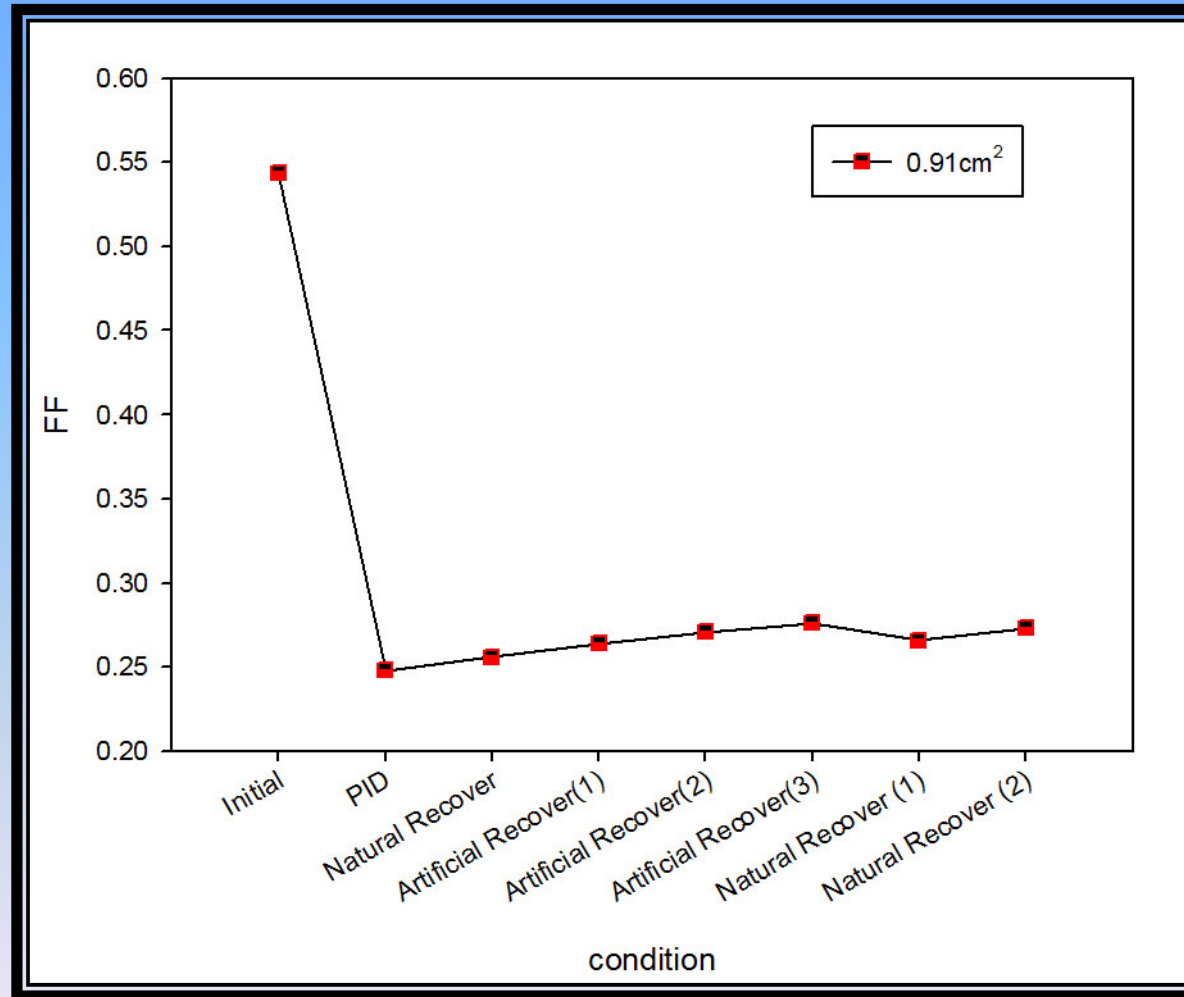
Degradation and recovery condition of solar module



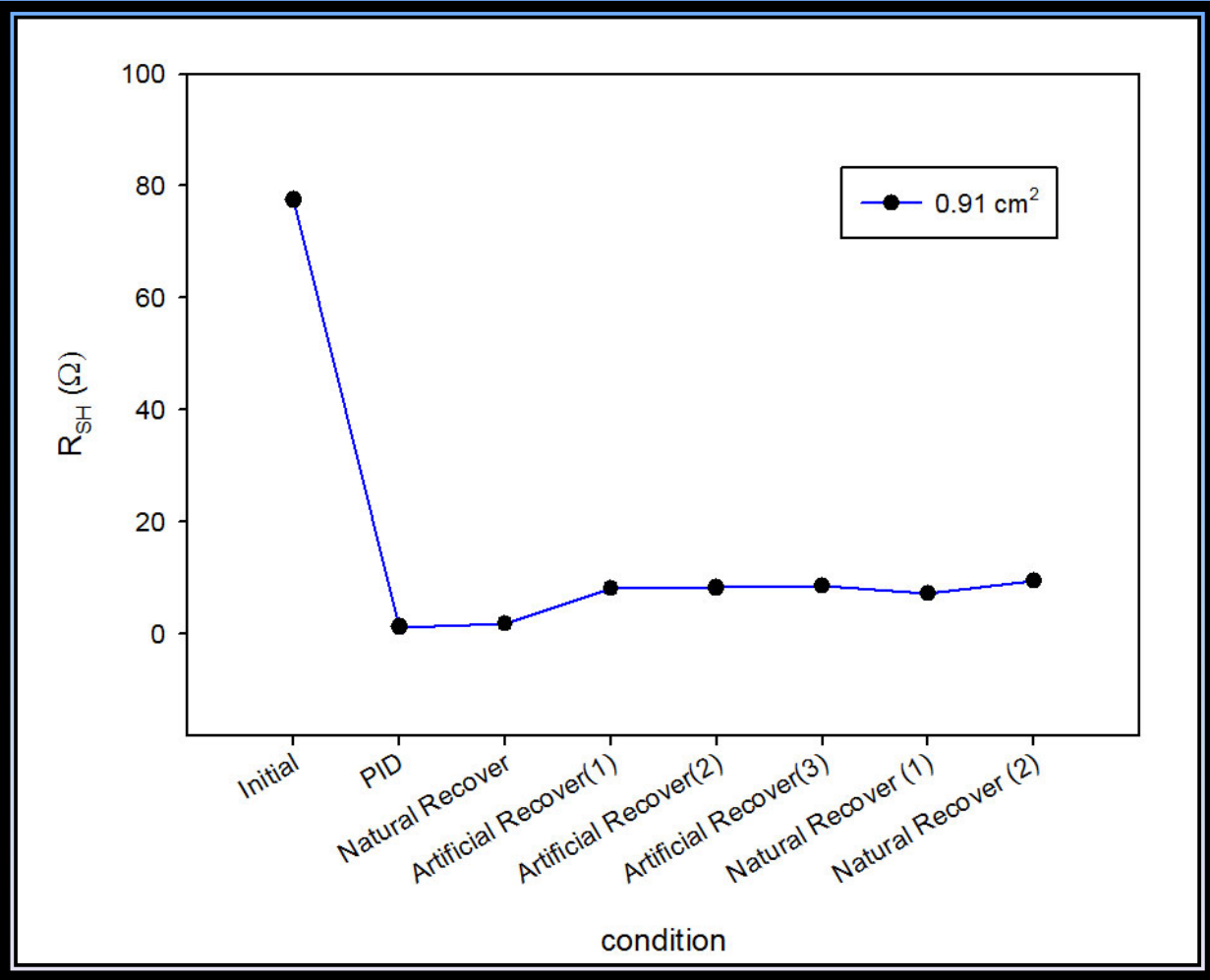
FINDINGS

Condition	FF	Eff(%)	R _{sh} (Ω)
Initial	0.544	8.670	77.551
PID (-2k/6h)	0.248	0.113	1.268
1 week later	0.256	0.238	1.843
AR1(+2k/3h)	0.264	1.5	8.158
AR2(+2k/3h)	0.271	1.618	8.36
AR3(+2k/3h)	0.276	1.623	8.59
NR 1	0.266	1.49	7.256
NR2	0.273	1.847	9.49

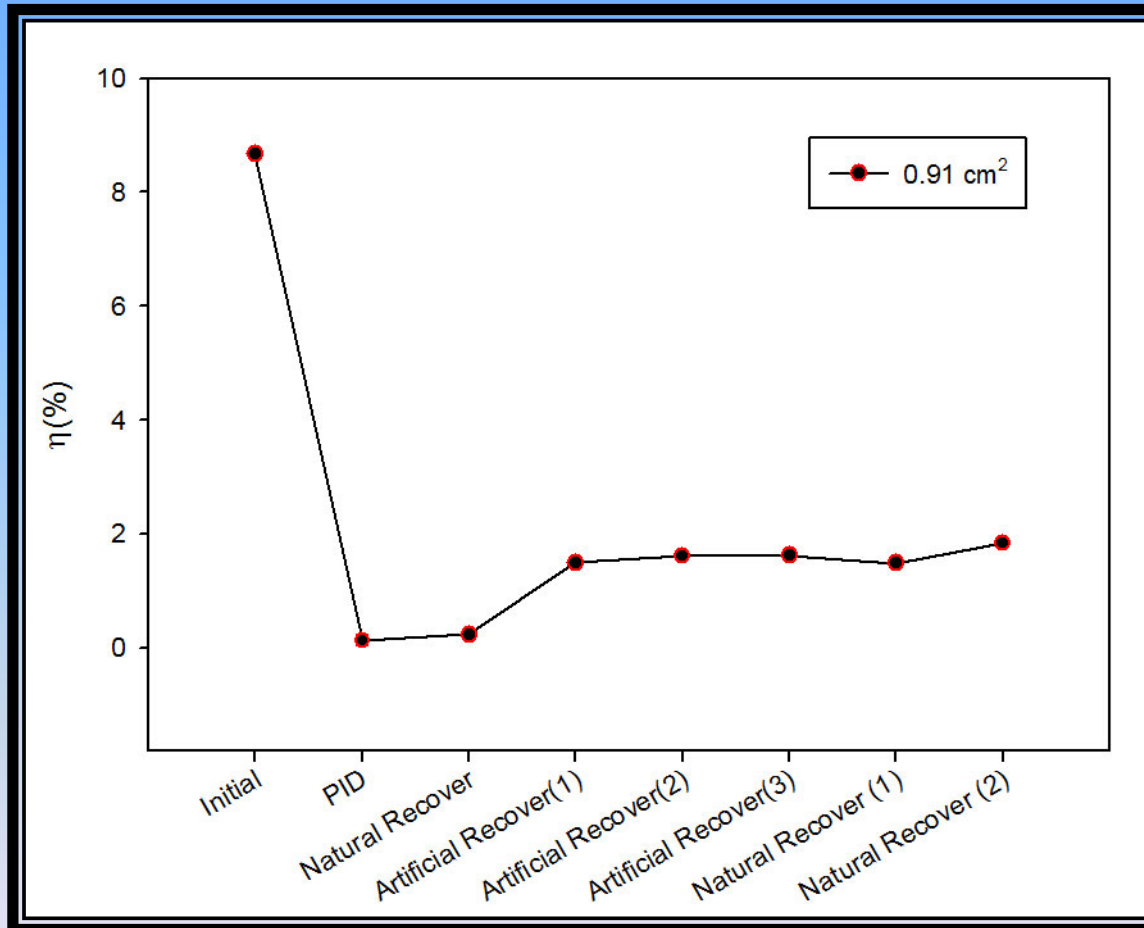
Fill factor of small module (0.91cm^2) at initial state, after PID, artificial and natural recoveries



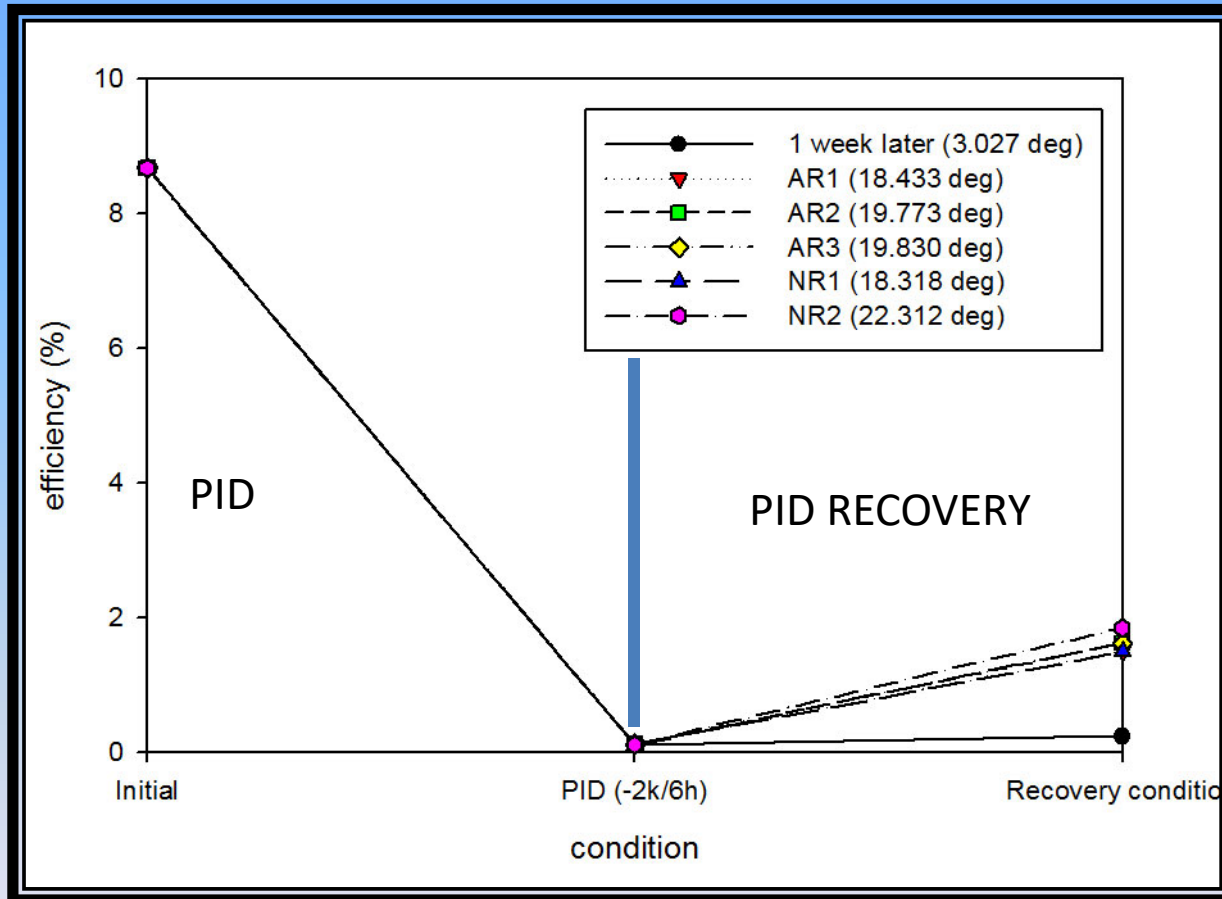
Comparison on shunt resistance of small module at initial state, PID & recovery



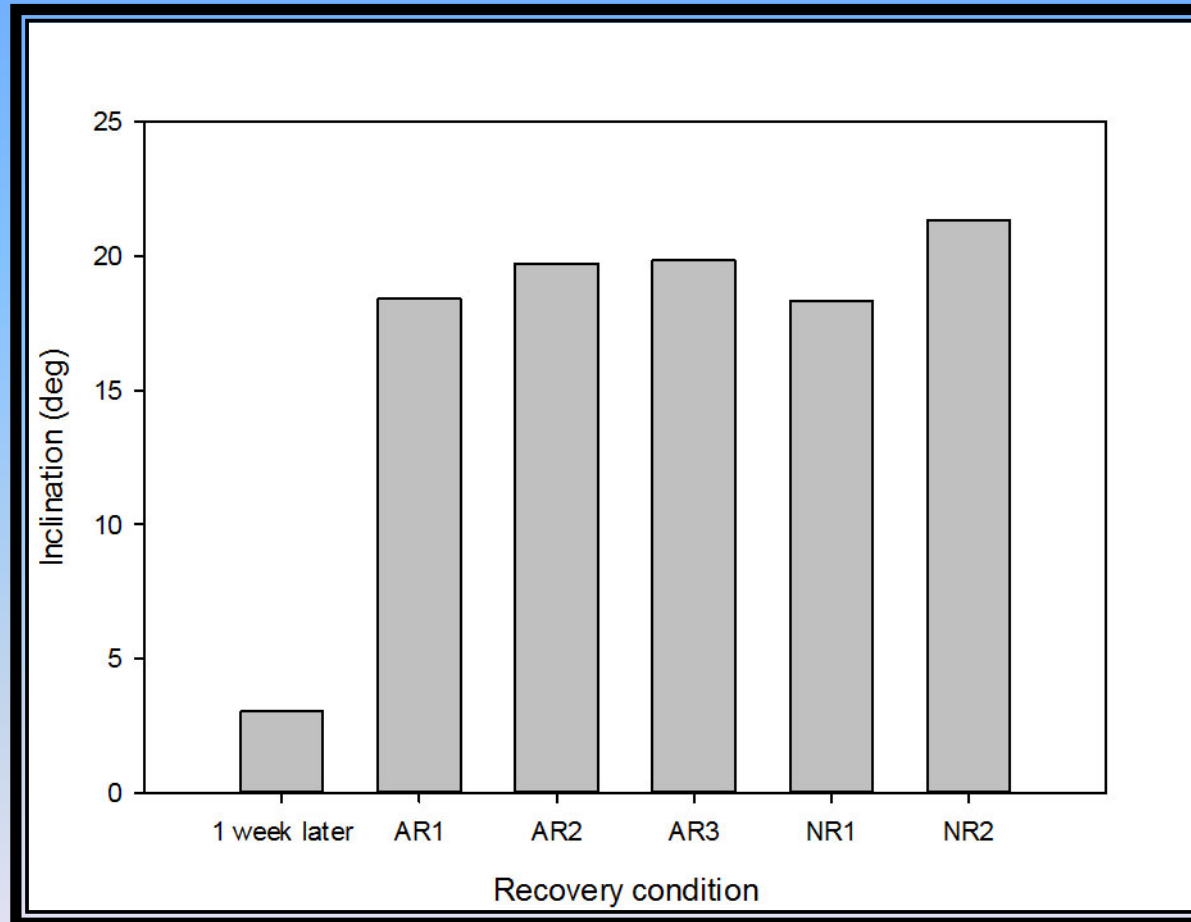
Comparison on fill factor of small module at initial state, PID & recovery



Angle of recovery for efficiency after accelerated PID of SOLAR MODULE



Inclination of SOLAR MODULE at different recoveries



CONCLUSION

- By El picture after PID implied the PID occurrence caused within small solar panel by - 2 kV for 6h at 85 °C.
- In this study, both recoveries are effective but it is not sure for smart recovery.
- Before the artificial recovery, natural recovery may cause within the solar panel 1 week later but 1 week is not enough to occur after artificial recovery.



**The sun is the primary energy source
for almost all energy flows
on the planet. It's time we started using it.**