Subcell Coupling in Tandem Solar Cells: Measurements and Modeling

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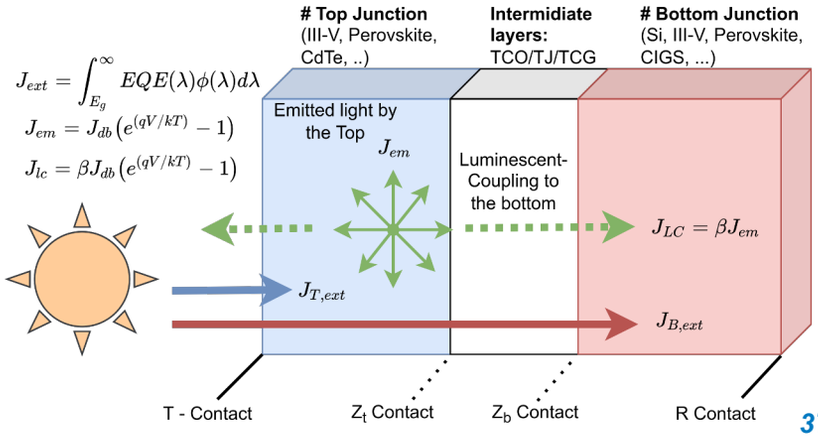
Tandem measurements

- ***ALWAYS control or characterize BOTH subcells e.g. measure bottom I_{sc} with top at OC & SC***
- ***Information comes from light, current and voltage***
- ***More terminals provides flexibility for characterization and power optimization***

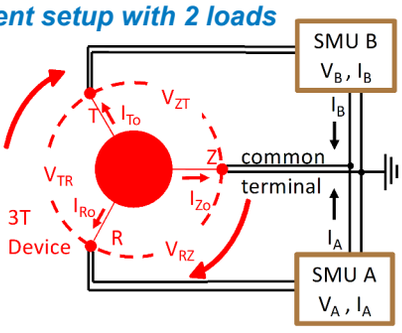


Tandem subcells ARE NEVER INDEPENDENT!
Number of terminals changes limitations

	Electrical coupling	***Optical coupling***
2T:	***Series current limitation***	***Luminescent coupling***
3T:	***Common resistance***	***Luminescent coupling***
4T:	***Potential shunt***	***Luminescent coupling***

If a subcell has a voltage……
it emits light (more prominent for good emitters like III-Vs and Perovskites)
If it emits light ……
the tandem has luminescent coupling
LC is up to $\beta = 4n^2$ times the emitted light

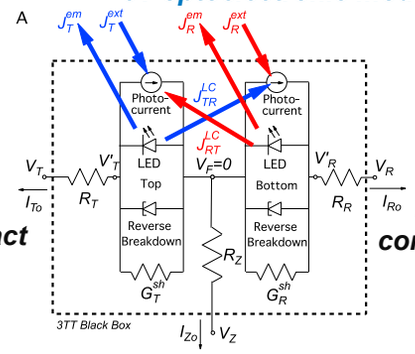
3T measurement setup with 2 loads



CZ, CR, or CT

T contact

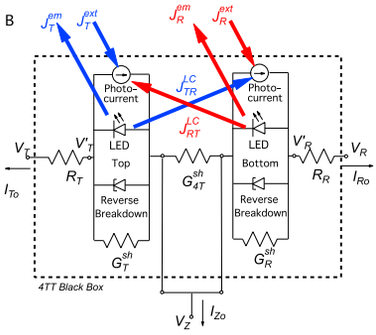
3T optoelectronic model



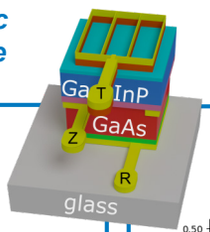
R contact

Z contact

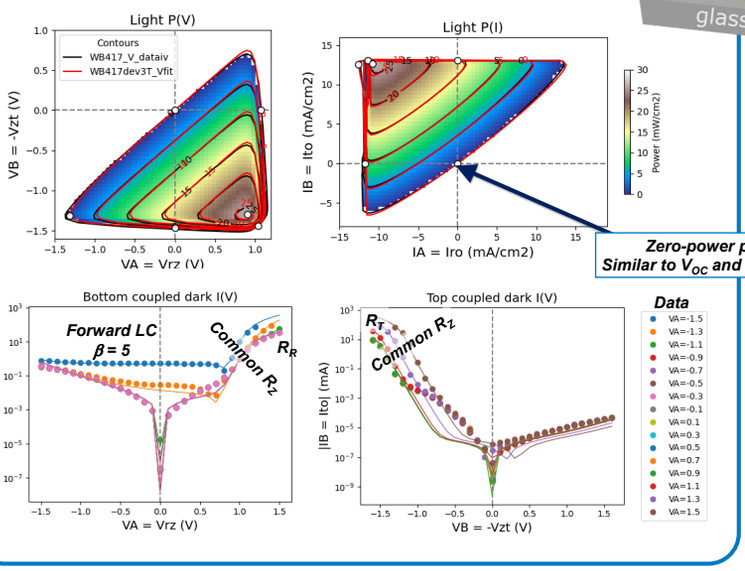
2T (I_{zo} = 0) and 4T (R_Z = 0) are special cases of 3T tandems



Tandem physics is material agnostic III-V 3T tandems are a great example

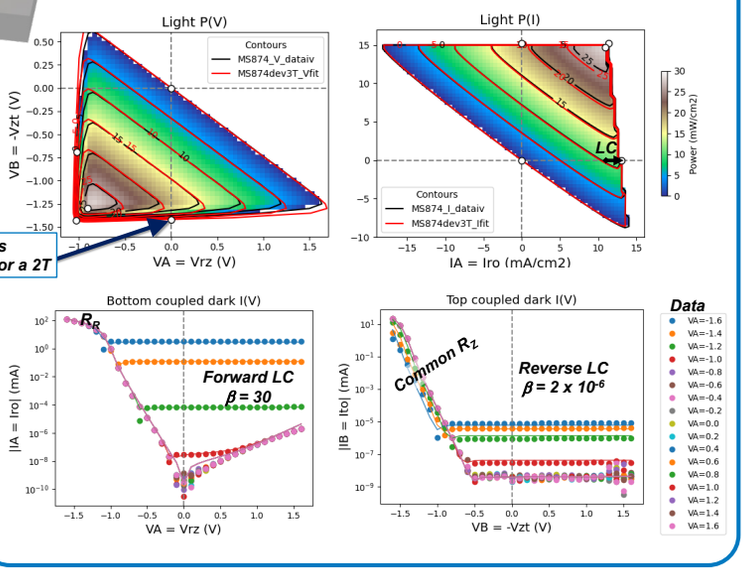


S-type GaInP/GaAs 3T



Zero-power points Similar to V_{OC} and J_{SC} for a 2T

R-type GaInP/GaAs 3T



Tandem modeling powered by python-based open-source PVcircuit
https://github.com/NREL/PVcircuit

Coupled dark IV curves are sensitive for fitting model!

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