M-SOLV Limited

OSI

One Step Interconnect

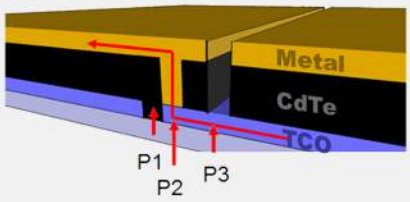
Technology to improve Thin Film PV manufacturing

Thin film PV cell and module efficiencies are improving fast and even challenging crystalline silicon. M-Solv's One Step Interconnect (OSI) drives this efficiency trajectory and costs less than conventional interconnection.

Thin Film PV:

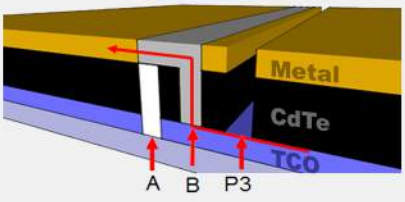
Conventionally thin film modules are made by various types of vacuum deposition of the thin film layers over the whole module area. These coating steps alternate with laser or mechanical scribing of the layers (usually known as P1, P2 and P3). These divide the module into strip-like cells connected in series (shown below). The drawback with this sequential approach is that the coating steps happen in vacuum, while the scribes are done in air; meaning the panel has to go in and out of vacuum systems several times during manufacture.

Conventional Process:
P1, P2 and P3 are laser processes that happen after the TCO, CdTe and metal deposition steps, respectively



To avoid this issue, M-Solv has developed a process called One Step Interconnect (OSI) where the full thin film stack can be deposited, uninterrupted and followed by a single pass interconnection process (shown below).

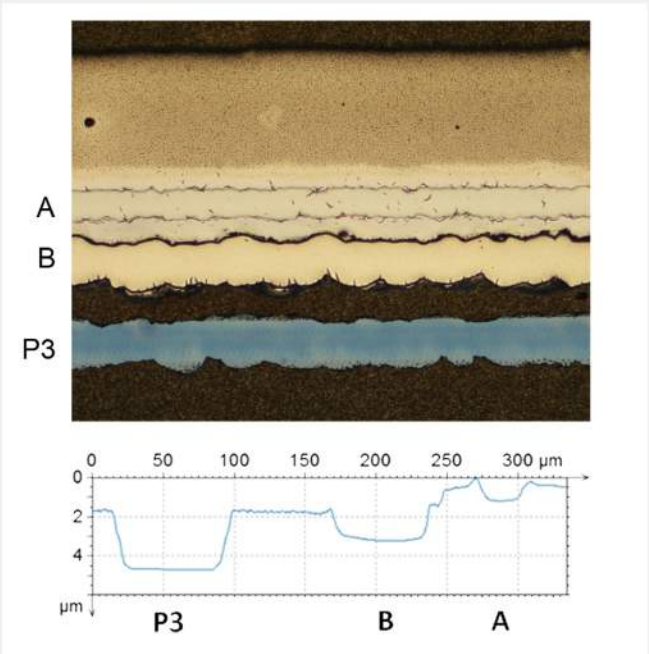
OSI Process:
A single pass of the process heads
Fast & self aligning.



After full stack deposition, depth-controlled laser scribes are made A, B, P3. A is filled with UV-cured insulating inkjet material, B is filled by inkjet with metal ink which bridges A making the interconnect. This all happens in a single pass of the process heads! Fast & self-aligning.

One Step Interconnect (OSI):

The laser and inkjet process heads can be mounted on a single machine and locked together by the mechanics and control system. The process is self-aligning and the interconnects can be made where the inactive "dead zone" between the first and last scribes is minimised.



A view of the interconnect through the microscope and cross-section from white light interferometer. P3 is an unfilled scribe to the TCO, scribe A is filled with insulator and the conducting ink makes a bridge from the TCO at the bottom of scribe B over the insulator to the back contact on the right of scribe A.

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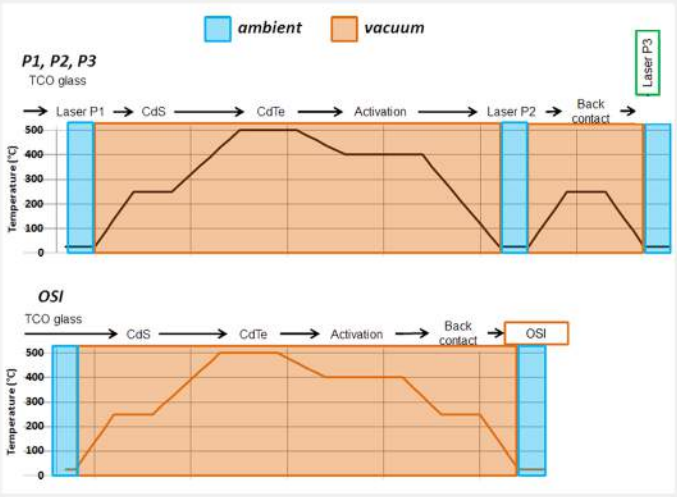
Production Line Advantages:

For the overall production line there are several advantages, including; three laser scribing machines are replaced with one OSI machine and several of the module's air-to-vacuum transitions are removed. The module never has to be exposed to air until the stack is complete. The vacuum-to-air transit can only take place near room temperature but most of the coating steps take place at high temperatures so heating and cooling stages are needed. Using OSI means that the temperature profile along the production line can be much flatter. This saves energy, makes thermal process control easier and removes heating, cooling and load-lock equipment from the line, meaning the overall panel manufacturing time is reduced because the line is shorter. The OSI process can help manufacturers to improve thin film PV efficiency and drive down costs.



Temperature vs time plot for a notional CdTe manufacturing process with gas-phase activation process.
Orange boxes = vacuum processes, Purple boxes = atmospheric; (a)conventional all-laser P1, P2, P3 interconnect (total ΔT=1100°C) (b) OSI: total (ΔT = 750°C).

M-Solv machines in production environment.

Advantages of OSI:

- Higher module efficiency
  - Less exposure of PV materials to air
  - Better process control (temperature, atmosphere)
  - Narrow interconnect (less 'dead zone')
- Less capital expenditure
  - 1 OSI tools replaces 3 laser-only tools
  - Less handling tools, conveyors, and deposition tools, load locks.
- Process/factory simplification
  - Reduction in number of process/handling steps
  - Reduced process time
- Separate thin film deposition from interconnect
- Suitable for all thin film PV technologies CIGS, CdTe, TF-Si.
- Suitable for roll-to-roll processing
- Divides and interconnects in a single process:
  - Depth controlled laser scribes
  - Inkjet insulator and metal
- Overall process is fast and cost effective
- High Efficiency – Low cost

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