

TECHNICAL ASSISTANCE REQUESTs:

Cost-Effective Interdigitated Back-Contact IBC Solar Cell Electroplating Metallization Equipment and Processes.

Abstract: A silicon solar cell is a simple p-n junction. These front side contact solar cells rated average production low efficiency of 19% can reach up to 23.5%¹ with PERC cell. The low efficiency of front-side contact cell is mostly due to high total series resistance (the sum of the rear metal contact resistance, the emitter sheet resistance, the substrate resistance, the metal front-side contact resistance, and the grid resistance) losses, optical losses and electron recombination losses.

Interdigitated back-contact (IBC) cell concept is characterized in that all non-precious metal contacts Al/Ni/Cu/Sn using sputtering and electroplating can be found on the rear side of the n-type silicon solar cell. With rated average production high efficiency of 23.6% and can reach up to 25%. This enables a front side optimized entirely for higher light absorption or very low optical losses without the requirements of contact formation. The resistivity of a plated metal contact system is generally much lower than that of a screen-printed metal contact because pure metal is deposited during the plating. A plated metal contact has a low contact resistance because it is formed on the surface of the diffused emitter whereas screen-printed contact is formed by etching the surface of the emitter. Since the contacts are all on the rear side, the contact layout can be optimized for transport properties irrespective of shading conditions. However, these advantages stand in opposition to higher process complexity, more expensive sputtering, electroplating processes and single process equipment. Physical Vapor Deposition (PVD or Sputtering) has poor deposition rate, uniformity improvement can be difficult and costly, and high system cost and complexity⁷.

We have simplified the standard & IBC solar cell metallization processes, lowered the costs of processing and equipment, increase efficiency with our innovation using existing technologies and developed new technologies with our fully-automatic, hi-throughput, fully-enclosed, light induced plating (LIP) Multi-ElectroP Metallization System (MEPM).

MEPM system is:

- ☐ 2-3 multi-chambers one system fully-automatic software robot and processes control,
- ☐ Hi-throughput with up to 3 different processes can be processed at the same time in each of the 3 chambers with one robot arm servicing all 3 chambers and input-output port.
- ☐ Processes can be changed quickly by a quick N₂ purge of lines, water/N₂ purge of chamber and software switching of gas lines.

MEPM System 4 basic areas:

1. Plating cells/Engines (3): Reaction Chambers, sensor monitored
2. Chemical tanks (4): Fast swap, closed chemistry, one system multiple processes
3. Electronics Plane: Smart control and algorithms
4. Backplane: Robot-arm, heaters, filters, pumps integrated into one system

REQUESTs:

Testing

- A.** Solar wafers PERC before front side contact screen printing 50 counts and completed PERC from same batch for comparison 10 counts.
- B.** Solar wafers IBC before back-side metallization 50 counts and completed IBC from same batch for comparison 10 counts.
- C.** SEM (Scanning Electron Microscope) X-section of wafers

Manufacturing/hardware integration

- D.** Determine balance of system cost reduction in term of complexity of robots, chemical pumps, exhaust systems, chemicals storage/delivery/waste.

- E.** Cost and safety implications
- F.** 3 Phase high power testing - thermal, reliability, safety shutdown, emergency mode
- G.** Safety shutdown of chemical tanks and delivery systems, safety sensors
- H.** Evaluating effect of mechanical and electrical loads on process parameters.
- I.** Manufacturing of the new prototype electroplating chambers for larger square solar wafer sizes 210 mm including semiconductor round wafers up to 300 mm in diameter. Schematic will be provided upon NDA, approval from our team.
- J.** Metal stainless steel semiconductor grade manufacturing of electroplating chambers covers. Schematic will be provided upon NDA, approval from our team.

Software Development

- K.** GUI software improvement for more user-friendly, in various software languages core source code programming will be provided upon NDA, and approval from our team.
- L.** SECS/GEM equipment interfaces with databases, PLCs, OPC program in .NET, Java, C++, Python.