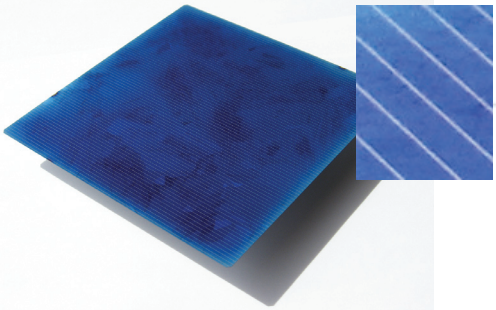
SYSTEMS

Aerosol Jet® Solar Lab System

For Development of High Efficiency Solar Cells



Aerosol Jet® Solar Lab Systems are ideally suited for developing next generation designs and processes for high efficiency solar cells.

Aerosol Jet Solar Lab System

Optomec's Aerosol Jet Solar Lab deposition system enables fine feature, <35 micron, non-contact printing of advanced photovoltaic materials at ambient temperatures onto non-planar surfaces without the need for masks or resists. Aerosol Jet's non-contact Direct Write™ solution enables the move to thinner wafers while also creating higher efficiency C-Si solar cells by producing narrower collector lines thereby reducing shadowing effects. To improve conductivity, a plating process is currently used to build the collector line height to 10 microns or greater. The Aerosol Jet deposition system is capable of printing a wide variety of materials such as fritted inks, etchants, dopants, and other advanced materials employed in next generation printed front and rear side C-Si and thin film technologies.

Advantages of the Aerosol Jet System for Photovoltaics

» Conformal, Direct-Write, non-contact printing
» Fine feature deposition (<35 micron)
» Uses advanced Aerosol Jet ready photovoltaic material
» Produces high integrity circuitry (no conductor breaks)
» Controlled deposition thickness
» Supports non-planar and thin substrates
» Improved yield (no pressure on wafers)
» Ambient temperature processing
» No stencils or masks required
» Easy to generate new print patterns

"Using Aerosol Jet technology in conjunction with Light Induced Plating, cell efficiency as high as 20.3% and fill factors of 80.1% were achieved for monocrystalline front junction silicon cells".
-Source Fraunhofer ISE

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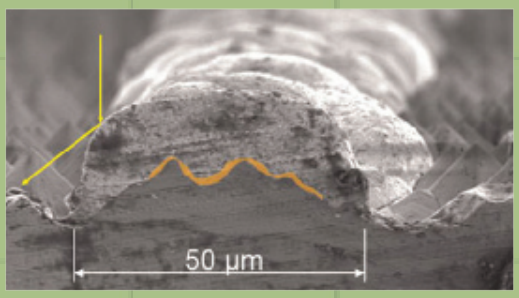
Aerosol Jet Deposition Process for Photovoltaic Applications



* 30 micron AJ printed contact Ag plated to 50 microns
* Effective contact width is 43% of printed width

The Aerosol Jet deposition process first aerosolizes conductive photovoltaic inks or pastes and then forms an aerodynamically focused droplet stream of the material. The droplet stream is deposited onto the photovoltaic wafer at specified process rates, up to 100mm/s per the conductor line pattern developed through CAD/CAM control.

The Aerosol Jet process employs Aerosol Jet-ready versions of next generation photovoltaic materials. After deposition and firing, the seed layer deposited by the system for the collector and/or bus lines, a plating process is employed to fully optomize electrical performance characteristics. Due to the round shape of the plated fingers, incoming light can be reflected from the fingers onto the active solar cell area which decreases the shadowing losses drastically. Thus the optical width of the finger is considerably less than the geometric width. Recent studies have shown that the optical width of an aerosol-printed and plated contact is only 43% of its geometrical width.

This Direct Write capability eliminates the need for screens or stencils required by traditional contact deposition processes. The Aerosol Jet Solar Lab system is capable of printing a wide variety of inks including advanced PV inks from Cabot Corporation, DuPont, and other leading ink manufacturers.

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Improved Photovoltaic Efficiencies

Aerosol Jet and screen-printed multicrystalline solar cell efficiency data courtesy of Fraunhofer ISE

	Voc [mV]	Jsc [mA/cm²]	FF [%]	$R_{S\ light}$ [Ωcm²]	η [%]
aerosol print +LIP	79 Fingers with a finger width of 70µm				
best cell	615	34.3	78.2	0.75	16.5
Ave/15	613	34.2	77.5	0.82	16.2
Screen print	65 fingers with a finger width of 100µm				
best cell	614	33.8	78.0	n.a.	16,0
Ave/10	609	33.5	75.3	n.a.	15.5

The Aerosol Jet Solar Lab system is ideally equipped for photovoltaic research and manufacturing process development applications.

Aerosol Jet Solar Lab System	
Minimum Line Width	< 35 microns (PV material dependent) 10 microns (other material dependent)
Ink Viscosity Range	1.0 to 1000 cP for printed contacts
Material Types	Modified screen pastes & nanoparticle
Droplet Size	1-5 microns Ø
Atomizers	Pneumatic (2)
Material Heater/Stirrer	Controls ink temperature, 25-60°C
Aerosol Jet Print Heads	Single nozzle and multi nozzle array
Stand-off Height	Up to 5 mm from substrate
Standard Work Area	300mm x 300mm
Platen Heater	Heats substrate up to 120°C
System Speed	200mm/s max (100mm/s typical) (linear speed)
Motion Accuracy	+/- 6 microns
Motion Repeatability	+/- 1 micron
Certifications	CE certified
System Dimensions	1020mm x 1375mmx 2240 mm (with hood; does not include dimensions for ErgoArm and monitor)
System weight	795 kg
Electrical	220 Volts AC, 30 Amps
Utilities	28 LPM Nitrogen Gas Input
Warranty	One-year limited warranty

ABOUT THE COMPANY

Optomec® is the world leading provider of additive manufacturing systems for high-performance applications in the Electronics, Biomedical, Photovoltaic, and Aerospace & Defense markets. The company's experienced product engineering and process development team is dedicated to creating solutions for breakthrough production capabilities.