

Global industrial gas company with a growing presence in the photovoltaics industry

Air Products has more than 35 years' experience of supplying essential gases and chemicals to the semiconductor industry. PES spoke to Jeff Handelman, General Manager, Photovoltaics, about the company's success story and about its commitment to the environment.



PES: Welcome to PES magazine. Can you first explain a little about the background of your company and how it serves the photovoltaic industry?

Jeff Handelman: Air Products is a global industrial gas company which has a significant presence in the electronics industry. For more than 35 years, we have been serving the semiconductor industry from its birth in Silicon Valley to its current home in places like Japan, Taiwan, Korea and China. As the thin-film transistor liquid crystal display (TFT-LCD) business developed, Air Products was there, supplying the necessary gases, chemicals and equipment for that industry's growth. Air Products has a long-standing history serving the crystalline photovoltaic (PV) industry with bulk gases and chemicals and its experience in TFT-LCD should benefit Thin-film PV.

PES: Can you tell us about your recently-launched SunSource Solutions and the benefits they provide?

JH: SunSource is a portfolio of gases, chemicals, equipment, on-site services, and project-management experience, essentially a full turn-key offering that will help provide a faster ramp-up and the ability to reach grid parity more quickly for PV manufacturing operations. APD's SunSource brand also enables Air Products' customers to understand our commitment to the PV market through this dedicated offering.

PES: How has the market for gases and materials within the PV industry evolved in recent years?

JH: The market has gone from a nascent industry to high-volume manufacturing being driven by economies of scale. The

plants we see being built are now in the 100MW range, up from single digits just a few years ago. In growing to that size, PV manufacturers will encounter difficulties. Air Products has already helped solve in the semiconductor and TFT-LCD industries. Air Products is the industry leader in large-volume supply chain solutions and brings that expertise to help drive down cost of ownership for PV manufacturers.

With the advent of thin film silicon manufacture, the need for bulk supply of silane and nitrogen trifluoride (NF₃) has become a basic requirement and customers are turning to providers who can ensure security of supply and the technical expertise necessary to handle these vital materials. Air Products has the largest bulk specialty gas supply (BSGS) fleet in the world and is the largest NF₃ producer with multiple plants in North America and Asia.

In addition, Air Products is a leader in the on-site supply of hydrogen and nitrogen, two other necessary gases for the production of thin-film PV panels.

PES: The company is recognised for its commitment to the environment. Can you give us an example of an environmental issue that you face with regards to the PV industry and what measures you're taking to minimise the effects?

JH: As the silicon thin-film process becomes more mainstream, the need to ensure that process remains eco-friendly becomes even greater. In the 90s, Air Products was instrumental in getting the semiconductor industry to switch from SF₆, the predominant chamber cleaning gas



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at the time to NF_3 , NF_3 , when used with appropriate abatement systems, remains the chamber cleaning method of choice in the semiconductor industry, as well as in TFT-LCD.

As the thin-film PV business continues to grow, it may be advantageous for manufacturers to switch to on-site fluorine (F_2) as a chamber cleaning gas. At the appropriate scale, on-site F_2 generation can be used, but must be carefully evaluated for safety hazards and other design considerations.

Thanks to its more than 30 years of manufacturing experience, Air Products is in the best position to help PV manufacturers evaluate the safety hazards and design considerations around which chamber cleaning gas to use in their facility.

PES: Besides the environmental stewardship, what other advice do you offer customers?

JH: As manufacturing base is growing in PV, those with less experience in the hazards and handling requirements of some of the materials have reached out for education and training. APD has taken the lead to ensure safe handling of these materials evolves responsibly. We have sponsored six silane safety seminars worldwide to educate customers on the proper handling of this vital material.

PES: There are a number of gases used in the manufacture of solar cell manufacture – do you offer companies efficient ways of managing the supply and storage of those gases?

JH: As companies move to high-volume manufacturing, our ability to supply needed materials through bulk or on-site production reduces cost and helps reach grid parity sooner. Air Products' BSGS provides better product consistency and reliability as well as improved safety performance which all results in reduced costs for PV manufacturers. Our on-site blending option reduces number of cylinder change outs and storage requirements, which also results in lower costs.

PES: The distribution and transportation of your gases must be a major priority for you. Can you explain a little about the systems you have in place to ensure safe practice?

JH: Air Products is a Responsible Care company that takes its product stewardship very seriously. In addition to only using highly-qualified distributors, we also provide significant training to our customers in the handling of our materials. In fact, in many instances, Air Products' MEGASYS team is on-site



to change out cylinders and perform routine maintenance on the gas delivery systems. Our containers are steel construction, have steel valves, and are designed in accordance with US Department of Transportation and similar global-compressed gas packaging standards.

PES: You have a broad product portfolio – which sector is showing the greatest signs of growth?

JH: With the advent of turnkey silicon thin-film factories from major OEMs, that segment should see significant growth. Air Products is well-positioned to serve this segment and is dedicating resources to drive that technology to grid parity sooner. A prime example is our expertise in plasma-enhanced chemical vapour deposition (PECVD) deposition. Air Products was recently awarded more than \$1.5m from US Department of Energy for research in developing additives that could potentially result in significant cost savings for thin-film PV manufacturers using this process.

PES: Air Products is a leader in semiconductor and TFT LCD materials, how is PV market different?

JH: While our expertise in semiconductor and TFT LCD markets has been useful, the PV market has some specific challenges as well. Our Very High Flow gas delivery system was designed specifically

for PV industry to reduce capital costs through using the appropriate materials of construction and functionality required by this industry segment.

Air Products' CG 1000 takes the company's chemical delivery expertise and solves a specific problem for the PV world. It was designed to reduce cost of ownership in Gen 1 doping and can reduce phosphorus oxychloride (POCL3) bubbler refill costs by up to 45%. On the material side, we are seeing enhanced supply chain activities as the volumes of materials differ for PV manufacturers versus other electronics producers.

PES: What single piece of information would you most like to share with our readers?

JH: Air Products' SunSource Solutions is a one-stop offering that combines materials, engineering, and project management services to get your PV fab up and running and on the road to grid parity. From construction to production to expansion, PV manufacturers can turn to Air Products' SunSource Solutions for the answers to all their PV challenges. If you want a Global supplier that will be your partner and help you remain competitive in this exciting new market, we recognise that your success means our success. ▲

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