



electronicsupdate

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Air Products Well Positioned to Serve Rapidly Expanding Worldwide PV Industry

With commitments to provide gases, equipment, and other services to six major solar panel manufacturers in the U.S., Europe, and China, Air Products continues to expand its support to this rapidly growing segment of the global electronics industry with a focus on thin-film, silicon, amorphous photovoltaic activities.

The rapid expansion of thin-film PV manufacturing could make up over 40 percent of worldwide photovoltaic production by 2012, according to a new report from Greentech Media and the Prometheus Institute for Sustainable Development. Thin film PV production could also reach a capacity of 10 gigawatts in the same timeframe, the report added.

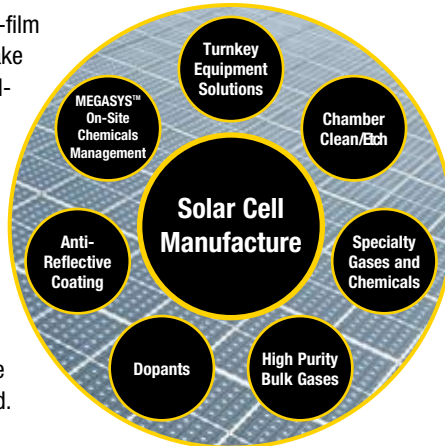
The "Thin-Film PV 2.0: Market Outlook Through 2012" report noted that in the first half of 2008 alone, more than \$200 million in venture capital was poured into the thin-film market, adding to the total of nearly \$1 billion invested in the market since 2007.

"Thin-film PV has quickly become one of the most heated market segments in all of renewable energy," said Travis Bradford, executive director of the Prometheus Institute.

With the demand for renewable energy and improved efficiency on the rise, Air Products is well positioned to take advantage of these emergent markets due to its experience in areas such as: large-scale hydrogen supply for cleaner transportation fuels, developmental work on the hydrogen economy, hydrogen vehicle fueling and infrastructure issues, leading natural gas liquefaction technology, advanced materials for lithium ion electrolytes for longer life batteries, and now the mounting demand for gases and services for photovoltaics.

"We view the solar market as a strategic growth engine for Air Products' Electronics Division. Our strong materials position globally, along with our technology, supply chain and project management experience fits well with the needs of this industry," said Jeff Handelman, general manager of Photovoltaics for Air Products.

Air Products is targeting major OEM manufacturers offering turnkey factories where venture capitalists and those associated with ICs and flat panel displays can literally buy an entire factory with a typical output for delivery in typically 12 to 18 months.



Materials and turnkey solutions for solar cell manufacturing.

XeCoveySM: A New Onsite Xenon Recovery Service by Air Products

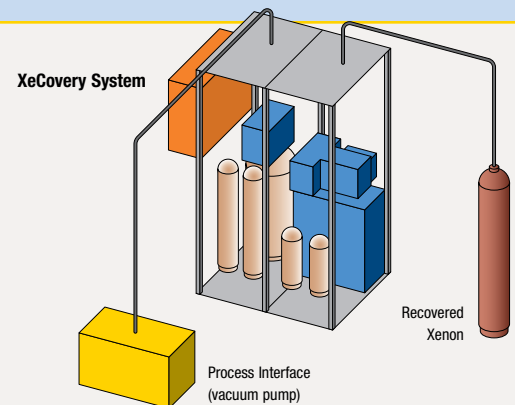
A range of uses for the noble gas xenon have conspired to strain the worldwide supply and drive up prices for the rare gas. With that in mind, Air Products has developed XeCoveySM On-Site Xenon Recovery Service, a new offering that provides a lower cost of ownership for customers using xenon within their manufacturing processes.

"Because of high xenon recovery rates, customers currently using xenon in their manufacturing processes could improve their security of supply and see savings of more than 50 percent in their cost of xenon by using the XeCovey recovery service, without incurring any additional capital outlay for equipment," said Gene Karwacki, commercial development manager for Air Products.

"In addition, customers concerned with the high cost of xenon can now continue using the gas in their processes and save valuable R&D time trying to change their processes."

Xenon has a number of unique properties that have attracted a variety of industries to use this atom, including semiconductor manufacturing. Applications within IC fabrication include high aspect ratio etching, a possible excitation medium for EUV lithography, and a means to facilitate polymer cross-linking to enhance protection of photoresist during etching.

(cont. on page 5)



Here is a conceptual depiction of the primary XeCovey On-Site Xenon Recovery Service system.

(cont. on page 5)

New ComPATSM-LoK Assurance Program Improves Material Compatibility

Getting things done right not only the first time, but also quickly, is advantageous for any company.

That's why Air Products developed its ComPATSM-LoK program to help assure the compatibility of porous low-k materials to enhance development and shorten processing times.

The ComPAT-LoK program focuses on advanced technology node challenges from new materials integration to provide minimal damage to PDEMS, high performance for the specific integrated product requirements, and integrated electrical testing.

According to John Caligiuri of the company's Advanced Integration Materials Group, integrating high-performance low-k materials is one of the greatest challenges to manufacturing copper interconnects for advanced logic devices.

"This is where the ComPAT-LoK compatibility assurance program can make all the difference. We've developed and proven this offering to be compatible with porous low-k films from first generation 2.5 films down to 2.0 low-k films for next generation technology nodes.

"The program focuses on integrated product chemistries, to reduce demand on the customer, and deliver proven technologies. It enables customers to get a head start on advanced technology integration, proving the extendibility of porous low-k beyond 45 and 32 nm," he noted.

Air Products' ComPAT-LoK program proves the extendibility of porous low-k beyond 45 and 32 nm with all aspects of porous low-k processing, including dielectric deposition, etch/ash, wet cleans, CMP, and post-CMP cleans. The

program was introduced in April 2007 and rolled out commercially earlier this year.

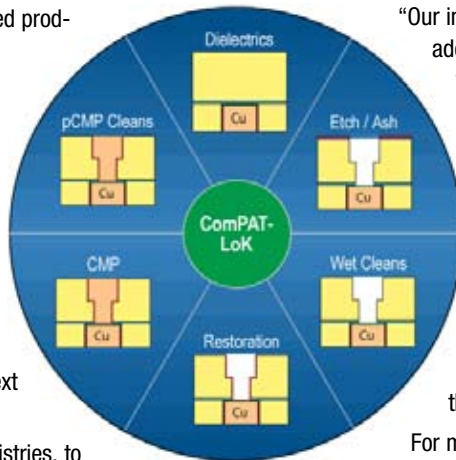
Dr. Laura M. Matz, Air Products' technical lead for the ComPAT-LoK program, said there are other important advantages to the integrated strategy of the program that not only produces compatible high-performance products, but also provides a team of experts dedicated to supporting customers' integration processes from R&D to high-volume manufacturing.

"Our internal team of experts works together collectively to address compatibility issues prior to bringing the chemistry to high-volume manufacturing, thereby lowering the customer's development time and costs, and helping them to achieve the highest probability of success. The team also enhances our own R&D by giving us a fundamental base to go back and modify our customer chemistries much more quickly," added Dr. Matz.

"We have received excellent feedback with customers telling us this is exactly the kind of program they need. It is much better to collaborate more closely with our customers versus just selling them product," she said.

For more information on Air Products ComPAT low-k program, visit our website at www.airproducts.com/ComPAT or listen to the podcast, www.airproducts.com/videos/popup/audio_0808_compat_lo_k.html accessible at our Electronics E-Learning Center.

Caption: The ComPATSM-LoK program covers these aspects of porous low-k processing.



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Air Products Supports SEMI High Tech U in Singapore and Taiwan

Air Products participated with SEMI, a global semiconductor industry association, in SEMI's acclaimed High Tech U (HTU) in Singapore in June, and sent representatives as instructors to teach, share semiconductor industry experience, and conduct mock interviews to prepare students for their careers.

SEMI HTU, which will be held also at Taiwan next summer, is an industry-driven math- and science-based career exploration program produced and presented by the SEMI Foundation, which supports high-tech education.

In Singapore, the program is a partnership among SEMI, the Singapore Economic Development Board (EDB), Air Products and many other semiconductor companies. It introduces secondary school students and teachers to the science of making semiconductors and career opportunities available.

This was the third HTU program held in Singapore. Air Products, also participated in the first HTU program when it was introduced in 2006.

The highly interactive three-day curriculum includes hands-on experiments that demonstrate semiconductor manufacturing concepts and explain microchip logic, as well as sessions on educational pathways and career planning.

Since HTU began in 2001, more than 50 programs have been delivered to thousands of students and teachers in the world. The program's success has attracted international interest.

"We hope to use HTU to excite students about math and science, and motivate them to pursue high-tech careers," said David Price, vice president and general manager of Asia Electronics. "We view HTU as an important investment in our youth and long-term development of a qualified industry workforce," said Al Chuang, general manager Southeast Asia/India Electronics.

HTU is being introduced to Taiwan because there is a rising demand among corporations for talented college graduates to keep pace with the booming electronics industry.

Air Products is one of five sponsors for the Taiwan HTU and will provide monetary support through the company's subsidiary in Taiwan. In addition, the Air Products Asia Technology team will offer technical knowledge and support during the course of the program and curriculum design.

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SEMICON Taiwan is an effective platform for building relationships and meeting with existing and new customers.

Extensive Electronics Portfolio Exhibited at SEMICON and PV Power Expo in Taiwan

The Asia Electronics team and Air Products San Fu, the company's Taiwan subsidiary, participated in SEMICON Taiwan 2008 in September, showcasing their extensive product and service portfolio under the global theme "Focused on What Matters Most." The largest microelectronics event in the region, this year's SEMICON Taiwan drew nearly 800 exhibitors and 33,000 attendees, maintaining its 2007 numbers.

The annual tradeshow has been an effective platform for Air Products to build relationships and meet with existing and new customers. This year the Air Products booth was designed with more open space to offer more conversation areas and included a bar counter for the first time to make the setup cozier. During the three show days, the sales team met and discussed market trends with many customers.

At the tradeshow, Air Products highlighted high-k and low-k solutions, the XeCoverSM xenon recovery system, and photovoltaic offerings.

In conjunction with SEMICON, Air Products also sponsored the inaugural PV Power Expo Taiwan. Joined by other key players such as Dupont at the PV Museum, a special exhibit presenting the global and Taiwan PV development roadmap, Air Products demonstrated its capabilities including the broad range of materials and other solutions to serve this booming market.

Both SEMICON Taiwan and PV Power Expo are organized by SEMI, a global semiconductor industry association.

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First NH₃ ISO Trailer Delivered in Taiwan

Air Products' Taiwan subsidiary, Air Products San Fu, recently delivered the first ammonia (NH₃) ISO trailer to Chi Mei Lighting Technology Corp. (CMLT). This is not only the first NH₃ ISO trailer Air Products delivered to its customer in Taiwan, but is also the first of this supply mode for NH₃ in the Taiwan market.

Through great team work and expertise, Air Products once again demonstrated its pioneering spirit and has brought great benefits to its customer.

CMLT is a subsidiary of Chi Mei Optoelectronics (CMO), one of the world's leading and well-known TFT-LCD panel makers. Air Products has a strong working relationship with CMO to whom it also supplied NH₃.

Air Products' southern Taiwan Electronics Specialty Materials (ESM) sales team approached this NH₃ opportunity when CMO started its LED business and set up CMLT. The ESM team proposed the NH₃ ISO trailer supply to meet the customer's consumption demand and worked closely with the global and local EH&S, EES, Product, Supply Chain, and Transportation teams. Working across the functions as a team, Air Products was able to show its NH₃ capability and expertise in the bulk specialty gas systems (BSGS) and ISO trailer design. Finally, it won the business in December 2007.

Due to their environmental friendliness, power-saving, and long-lasting benefits, LEDs have been generally used in all kinds of daily life appliances since the 1990s. LED chipmakers are heavy NH₃ consumers.

The global LED industry market output was \$14.7 billion U.S. in 2007 and is expected to reach \$21.2 billion U.S. in 2010. As a result, more new players have entered the market in Taiwan. Leading IC/LCD players have either started their LED businesses or shown interest. NH₃ trailer supply can save costs for LED chipmakers and eliminates cylinder change outs.

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Air Products San Fu Electronics team with the NH₃ ISO trailer at the Tainan CMLT facility.



Air Products Introduces GASGUARD® Very High Flow System (VHF) for Bulk Specialty Gas Delivery

Air Products is pleased to welcome a new member to the family. Introduced at this year's SEMICON West, the GASGUARD® Very High Flow System (VHF) for bulk specialty gas delivery is the latest offering from Electronics Equipment & Services (EES). The family also includes Air Products' industry-leading Bulk Specialty Gas Systems (BSGS), GASGUARD® Source Systems, and GASGUARD VMBs and DVBs.

You might not know this, but Air Products has sold more bulk gas systems than all of its global competitors combined.

This significant experience was leveraged by the development team to create a system specifically designed for the needs of IC, PV, and thin-film transistor LCD manufacturers. A single VHF unit can economically deliver 1,000 standard liters per minute (slpm) or more of specialty gas, contingent on service and application.

"As the demand for process gases to the (PV), and TFT-LCD industries continues to grow, we have been able to provide gases in the safest and most cost-effective manner," said Joe Stockunas, general manager of EES. "Our new VHF enables fab operators to lower their cost of ownership by reducing capital, exhaust, and system footprint."

For device manufacturers using high volumes of specialty gases in their factories, VHF offers higher flows, improved cost of ownership, and product dependability, what's needed in this challenging market, said Stockunas.

"We're proud to announce the newest member of the family, VHF, as another example of the Total Solution we can offer to the customer's process gas needs, equipment, gas, turnkey installation, and on-site services."

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New BPS Materials Benefit Packaging, Testing, Assembly

New from the Air Products Electronics Division is our BPS (Better Process Solutions) line of products. BPS wet chemistries are an efficient and simple way of removing metal oxides, photoresist, and flux from wafers without damaging the underlying metals. These materials will allow the customer to lower costs through improved yield and lowered reruns.

Currently under evaluation at several customer fabs where they are proving to be quite effective, BPS materials could bring about a major change to backend packaging.

"Today, most operations, such as probe and test, flip chip, sawing, and wire bonding, see a variety of problems due to the presence of high oxide and organic residue levels" said Raj Ramamurthi, Air Products' manager of BPS Products, "and we have discovered that it is beneficial to clean them first to make these operations more efficient. BPS solutions have short processing times and a much lower cost associated with them than current techniques.

The bottom line is that we are helping chipmakers lower their costs."

Ramamurthi said the company developed the BPS line about a year ago with the support of Terence Q. Collier, president of CVInc., Dallas, Texas. Collier is an expert in packaging, testing, and assembly and now serves in a consulting role as an applications and sales engineer to Air Products.

"We wanted to become more involved in packaging operations and after talking with Terence, we realized that we could find some important applications based on our wet chemistry experience. We not only have the formulations for many electronics applications, but also substantial high-volume manufacturing capabilities in Dallas; Easton, Pa.; and Seoul, Korea, as well as global labs at Allentown, Pa., Dallas, Giheung, Korea; and Hsinchu, Taiwan."

"By cleaning wafers with BPS wet chemistries as they enter backend operations, chipmakers can prolong the life of standard or high-end probes by as much as six months," said Collier, adding "If the probe is making 10,000 touchdowns on an as-yet uncleaned wafer, it gets dirty quickly. Also, cleaning reduces false readings when testing for electrical properties. Cleaning first increases accuracy, boosts yield, and reduces cycle time. We like to say, 'Clean the wafer, not the probe card.'"

Ramamurthi noted similar advantages with wire bonding. "Pre-cleaning means that more wire bonds will stick versus trying to adhere to dirty or corroded pads. And, our BPS formulations are an advantage over plasma etching. Pick the wrong plasma and you can damage the entire wafer.

"With dicing and sawing, BPS solutions provide the benefits of traditional surfactant-based dicing solutions, effectively removing saw slurry through better wetting, while also removing metal oxides from bond pads and mitigating their regrowth" he added. "BPS products replace and outperform other available dicing solutions."

"Finally, BPS wet chemistry brings a lot of advantages to flip chip assembly, mostly through improved cleaning," said Collier.

More details on our BPS offering are available at www.airproducts.com/bps.

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Terence Collier and Raj Ramamurthi

BPS Product Line

Dicing Solution and Oxide Removers

- **BPS-729 solution.** This surfactant-based product effectively removes saw slurry through better wetting. Simultaneously removes oxide and prevents regrowth with little effect on underlying metal. Accommodates most existing tools without retrofits.

Oxide Removers

- **BPS-172, BPS-170, BPS-100 and BPS-101 solutions.** Designed for metal or aluminum oxide removal with low etch rates on most metals. Process time is usually less than five minutes. These are suitable for standard wet bench processes and wafers may be reworked without damaging films.

Photo Resist and Flux Removers

- **BPS 125 and BPS-130 solutions.** Remove photoresist, flux, flux residues, die attach residues and cured or partially cured polyimide. They do not attack passivation layers or most exposed metals. They also have a process time generally less than five minutes and are suitable for use in standard rinse tools.



Samsung Electronics' vice chairman and representative director Y. W. Lee (left) presents the "Distinguished Service Award" to Air Products HYT's representative director Y. S. Kwak.

Air Products HYT Wins "Distinguished Service Award"

Air Products' wholly owned subsidiary in Korea for the electronics equipment and services business—Air Products HYT—was awarded the "Distinguished Service Award" by Samsung Electronics Group in June. Celebrating the Samsung Group's 70th anniversary of its founding, the award recognizes suppliers who have scored high points in evaluations and have maintained long term partnerships. Air Products HYT was one of three companies in the semiconductor category winning this prestigious award.

(cont. on page 6)

Air Products Well Positioned to Serve Worldwide PV Industry (cont. from page 1)



For customers making a significant investment in the PV market, only Air Products brings its leadership in total gas and chemical supply with a complete turnkey offering.

Handelman said, "To go with that turnkey factory, these companies need a gas supplier to supply silane, nitrogen trifluoride, hydrogen, nitrogen, argon, helium, dopants, and other gases and chemicals, as well as all necessary delivery equipment."

Dave Taviani, North America PV Business/Global marketing manager, said, "Air Products has created a complete turnkey, backpad offering that covers all of the chemicals, gases, and delivery equipment required to run a PV factory. Not only does the customer receive a basic package, but we also offer a team of MEGASYS® technicians to help manage the gases, as well as the benefit of more than 30 years of experience in cost-effectively and safely handling these materials.

"Equally important, we are focused on what matters most to many PV manufacturers—lowering their cost of ownership and achieving grid parity," Taviani said.

Among the latest PV projects awarded to the company is a contract to supply liquid nitrogen, oxygen, argon, and hydrogen to Schott Solar's new production facility in Albuquerque, N.M. The new plant, which will manufacture photovoltaic modules and receivers for concentrated solar thermal power plants, is expected on-stream in the spring of 2009.

"We are proud that Air Products' expertise in the safe and efficient handling and delivery of bulk liquid gases helped win this new business and we look forward to growing with Schott Solar in the future," said Handelman.

(cont. on page 6)

China's Best Solar Picks Air Products

Air Products has just signed a turnkey gas supply contract with China's Best Solar Hi Tech Co., Ltd., to provide on-site liquid bulk gases, specialty gases, and gas equipment for its new thin-film PV facility, one of the world's largest. Located in the Wuzhong Economic Development Park in Suzhou, Jiangsu Province, it will have an annual solar module manufacturing capacity of 330MW.

XeCovary™: A New Onsite Xenon Recovery Service by Air Products

(cont. from page 1)

Other uses for xenon include fuel for ion propulsion engines, an additive for very bright, low energy lamps for lighting and displays, as well as a delivery source for fluorine (XeF₂) in MEMS processing. Future uses as an anesthetic and blanketing gas to reduce brain trauma after injuries are also emerging.



Our XeCovary Xenon Recovery Service offering.

Karwacki said with demand and prices on the rise, there is a growing concern that cost will hamper its applicability. This is the situation within semiconductor manufacturing, where the price of xenon has risen, while device prices have continued to drop. Besides higher costs, the potential impact to the industry is the need for additional research to mitigate the use of xenon in already established manufacturing processes, which compounds the cost issues.

Because it is an on-site service, the customer's investment is limited to costs associated with installation and utilities to operate the equipment. Air Products assumes responsibility for owning, operating, and maintaining the units placed at a site. The process is capable of extracting from parts-per-million to percent levels of xenon from effluent streams. An enriched mixture of recovered xenon (typically in the percent levels) is compressed and stored. Full vessels are then transported offsite for distillation and certification as research-grade xenon.

In the XeCovary system (See page 1), Karwacki said effluent gas from a process unit (e.g., a vacuum pump) is diverted towards the recovery system when xenon is present within the gas stream. This signal can either be from the customer (e.g., mass flow controller), or from an installed sensor.

The extraction process can be designed so that either a single unit can be installed on a process tool (i.e., for high xenon demand), or multiple tools can be interfaced into a single unit.

"This is especially attractive for processes that only periodically use xenon," added Karwacki.

The XeCovary recovery service is based on an Air Products' patented technology (U.S. 7,285,154 B2) incorporating Vacuum Swing Adsorption (VSA).

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“The Mechanical Properties of Organosilicates: Effects of Methyl and Methylene via Theory & Simulations,”

Brian Peterson, Mary Haas, Mark O’Neill, Spring 2008 MRS Annual Meeting.

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news of interest:

New to the Electronics E-Learning Center

Four new podcasts are available at our Electronics E-Learning Center (www.airproducts.com/electronics).

1. ComPat™ Materials Compatibility Assurance Program: Addresses semiconductor manufacturers featuring comments from Dr. Laura Matz and John Caligiuri.

2. ComPAT Compatibility Assurance Program—Next Generation: Dr. Mary Haas describes advances in the ComPAT Assurance Program

3. The new XeCover™ On-site Xenon Recovery System: Gene Karwacki discusses this new service that can be retrofitted to existing manufacturing processes and which can provide savings to xenon users.

4. High-k Technology: Iain Buchanan talks about high dielectric constant materials for advanced memory devices.

This issue includes separate stories about these offerings.

The Air Products Electronics E-Learning Center is your resource for our latest technical information. You can download all podcasts, as well as pick a topic and listen to narrated PowerPoint presentations, or download recently published articles, and technical papers.

DA NanoMaterials Unveils New Slurry

DuPont Air Products NanoMaterials LLC, a 50/50 joint venture of DuPont and Air Products, unveiled CoppeReady® Cu3988, an innovative copper CMP slurry with enhanced polishing capabilities for advanced technology nodes. DA NanoMaterials continues to provide innovative products that deliver superior performance reliably with reduced total cost of ownership.

CoppeReady CU3988 copper series slurry was developed to improve copper dishing, erosion, and over-polish window targeting 45nm and 32nm technology nodes.



DuPont Air Products NanoMaterials L.L.C.

The product contains a particle with an optimized zeta potential, which has the capability to increase suspension stability and eliminate particle aggregation. This slurry is designed with low solids concentration (<1 percent), resulting in excellent defect performance. Additionally, a dual inhibitor system provides superior dishing performance and tunable polish rates to meet customer-specific process requirements.

By using different dilutions and eliminating the need for pad cleaning chemicals, Cu3988 slurry meets challenging cost of ownership targets for current and future technology nodes.

“CoppeReady Cu 3988 slurry is a superior product that provides an engineered solution to our customers. It enables high copper removal rates at low pressure, excellent topography performance, industry-leading defectivity, and an improved total cost of ownership,” said CEO Edward Shober of DA Nano Materials. “This new offering extends our already successful copper product portfolio used in production at a number of major global customers.”

DA Nano Materials, Tempe, Arizona, markets its CMP slurries under the CoppeReady, MicroPlanar®, Syton®, and Mazin® trademarks.

Showa Denko Joint Venture Extended

Air Products and Showa Denko will extend their 10-year production joint venture (Showa Denko Air Products Co. Ltd.) for etch and chamber-cleaning products such as CF₄ and C₂F₆ by building a new production facility to manufacture C₄F₆ in Kawasaki, Japan. The new C₄F₆ plant is expected to be completed in the first half year of 2009.

Showa Denko Air Products (SDAP) was formed in 1996 to capitalize on Air Products’ fluorine handling capabilities and Showa Denko’s technical and operating expertise in large-scale perfluorocarbon production facilities.

Air Products Well Positioned to Serve Worldwide PV Industry (cont. from page 5)

In addition to being a leading supplier of gases and chemicals to the global PV industry, Air Products is committed to sharing and exchanging knowledge to enhance renewable energy and sustainability choices. Conferences, trade shows, and professional organizations are an important way to achieve this.

In September, Air Products exhibited at the 23rd European Photovoltaic Solar Energy Conference and Exhibition (PVSEC) in Valencia, Spain, with 4,200 delegates from 87 countries and 715 exhibitors.

The company displayed the new amorphous silicon thin-film photovoltaic module manufactured by Signet Solar at its Mochau, Germany, facility using Air Products’ materials. The Signet panel is a thin-film solar module manufactured in much the same way as thin-film transistor-liquid crystal displays (TFT-LCD) are produced. With Air Products’ support, Signet was up and running in just 10 months.

“Momentum is definitely building for the PV industry and with our extensive electronics experience, evolving technology and global reach, we are ready to support our PV customers. As we define and differentiate our offering by building our cost roadmap to reach the grid parity inflection point, we have the ability to influence and proliferate growth in the solar segment,” said Handelman.

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Air Products HYT Wins “Distinguished Service Award” (cont. from page 5)

“We started business with Samsung Electronics in 1980 and since then our supply scope has been growing. And so has our partnership and relationship,” said S. Y. Lee, president of Air Products Korea.

“A symbolic landmark in Samsung’s 70 years of history, the award is indeed a great recognition of our team’s commitment and hard work that make Air Products different,” continued Lee.

Samsung Electronics is the world’s leading DRAM and flash memory/TFT-LCD manufacturer and the Number One capital spender within the global semiconductor industry. Air Products HYT provides MEGASYS® Gas and Chemical Management to 11 memory and seven TFT-LCD Samsung fabs in Korea.

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tell me more
www.airproducts.com/electronics

company information

Air Products serves customers in industrial, energy, technology and healthcare markets worldwide with a unique portfolio of atmospheric gases, process and specialty gases, performance materials, and equipment and services. The company has annual revenues of \$9 billion, operations in over 40 countries, and over 20,000 employees around the globe.

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