Electronic Materials

NewsLines

At Home Base and on the Road: AZ's Applications Team Works for You

They're troubleshooters. They're data gatherers. They're a bank of knowledge and technical support. Eight experts with 160 years of experience in the semiconductor industry comprise AZ Electronic Materials' Applications Engineering team.

This versatile team assists customers both on-site and off with new product evaluations, process issues and optimization, and planning for future requirements.

"While some companies rely heavily on our applications support, we would strongly encourage more of our customers to do so," says Aldo Orsi, Western region Sales and Applications manager. "We provide a valuable service helping customers develop and optimize their processes."

The team members are quite at home in fab environments—they've worked a combined 148 years in lithography with 86 years of direct experience in the fab. All of the team members have a solid grounding in AZ products, and they have a complementary array of specialties. When customers have particular needs, AZ selects the engineer with the appropriate expertise, for example advanced resist process optimization, thick film resists, or bottom antireflective coatings.

▲ *Applications engineers Alberto Dioses and John Sagan support customer-specific requests and new product development in AZ's functional testing fab in Somerville, N. J.*

The engineers' expertise goes beyond lithography. Some assist customers with process integration using their expertise in areas such as implant, strip, surface preparation, wet etch, dry etch, metrology, and wafer tracks.

AZ's engineers are so well trusted and respected that some companies have given them contractor's badges so they can work freely in their fabs on joint development and ongoing projects. "That's the type of relationship we strive for," says Orsi, "where we are working alongside our customers to help develop and optimize processes. At the same time we learn about our customers' future needs so that the AZ organization can plan to have the right products available when they need them."

When asked about their greatest challenge, the engineers offer a resounding response that keeping current in such a dynamic industry is at the top of the list. They never stop learning about products, processes, and equipment. They pride themselves in their ability to troubleshoot problems in a quick and efficient manner, and keeping current is the only way they can continually do this.

AZ's applications engineers are immersed in the technology. Six are field engineers that spend approximately 50 to 70% of their time at customers' sites. They are Ron Bradbury, Richard Collett, Steve Kusserow, and Ernie Sison based in the Eastern region and Jeff Griffin and Tim Watkins in the Western region. When not on-site with customers, they spend time developing data packages and presentations, providing telephone support, and interacting with other groups within AZ, such as Sales and Marketing and R&D, to see that customers' needs are being met.

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Clariant

AZ's Applications Team Works for You

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Two applications engineers, John Sagan and Alberto Dioses, work exclusively in-house at AZ's functional testing fab in New Jersey. They support customer-specific requests for data generation, including 193 nm photoresist/bottom antireflective coating combinations to meet the most advanced lithography needs, as well as characterizing and optimizing new products and processes for R&D. They also assist in generation of new product data packages for Sales and Marketing.

While these two engineers stay put in New Jersey, travel takes some of the others thousands of miles from home. "The AZ Applications Engineering Team's work spans the globe," says Brad Williams, Eastern region Sales and Applications manager. "Not only do we support customers in the United States, but we also support the efforts of our global AZ affiliates worldwide when they need us. Likewise they send experts here when needed." Members of the U.S. Applications Team have visited customer sites in England, Wales, Scotland, France, Germany, Italy, Ireland, Holland, Slovakia, Israel, Japan, South Korea, China, and South Africa in the past couple of years.

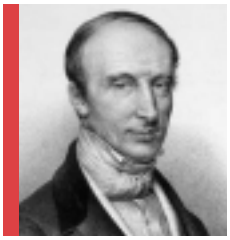
The team members enjoy working closely with so many people at many different companies. Over the years, they have developed close customer relationships and close personal relationships with the many people whom they have come in contact with in this dynamic industry. They're available to listen and to work for you. Contact your local AZ Sales representative to schedule applications support. ▲

Understanding Cauchy Coefficients

by Ralph Dammel, Ph.D.

As photolithography engineers and technicians, most of us use a set of numerical constants we refer to as "Cauchy coefficients," on a daily basis. Cauchy coefficients are used to describe the manner in which the real part of a given material's refractive index varies with wavelength. A deeper understanding of Cauchy coefficients, while secondary to the daily issues we typically encounter, can prove extremely valuable under a variety of circumstances.

The 19th century French mathematician Augustin-Louis Cauchy devised



▲ *Cauchy (1789-1857)*

an equation to describe the refractive index as a function of wavelength (refractive index dispersion) as part of his theory of electromagnetism. The theory was incorrect, but the equation is still commonly used since it fits dispersion data reasonably well if (and only if) the wavelength range is limited to regions of little or no absorbance. Of course, this limitation usually is not an issue for photoresist thickness measurements, but it must be carefully considered when measuring BARC materials because they may have high absorbance in the metrology wavelength range!

For the purpose of measuring film thickness in a photolithography environment, only the first three constants of Cauchy's formula (commonly referred to as A, B, and C) are used. A typical indication that the fit is sometimes improperly extended to regions of non-negligible absorbance is that the B parameter may become negative. A negative C value may be caused by the same error, but there are also other ways for C to become negative. There are alternative formulas (e.g., the Sellmeier equation with Urbach absorption) that can be used to describe low levels of absorption, but for highly absorbing materials, other approaches must be considered.

Cauchy's Dispersion Formula

$$n = A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4}$$

where the B and C numbers given depend on the unit of length (remember: A [dimensionless], B [length^2], C [length^4]). Note also that the Cauchy parameters are sometimes called n_1, n_2, n_3. For use in measuring photoresists, terms to only the fourth power are used. For glasses and other applications, however, terms of up to the 16th power are sometimes used.

Converting the Cauchy dispersion equation from one set of units to another can be rather confusing. Since some tools require input in nm or µm and others require Angstroms, proper unit conversions can be critical in developing accurate measurement programs. Here is a unit conversion table:

To convert from µm to:	nm	Å
Multiply A by	1	1
Multiply B by	10^6	10^8
Multiply C by	10^{12}	10^{16}

Another common source of confusion is that A, B, and C are also used to symbolize a photoresist's Dill parameters, which are something entirely different!

Last, since Cauchy is a proper name it is not correct to use the plural "Cauchies." It should be "Cauchys." But since that looks a little strange, I prefer "Cauchy coefficients" or "Cauchy parameters"! ▲

Customer Corner

AZ Rates Top Score Ever on ANADIGICS Audit

AZ Electronic Materials has achieved the highest score ever of any manufacturer to ANADIGICS' wafer fabrication unit on its quality and business management systems audit.

AZ's photoresists, developers, and ancillary chemicals are critical to processes in ANADIGICS' wafer fabrication manufacturing. "As part of our integrated supply chain management program, we thoroughly audit key critical suppliers to align our needs with our suppliers' capabilities," explains Barry Hartnett, senior engineer, process quality wafer fabrication engineering. "In our demanding markets we require our suppliers to adapt to constantly changing market conditions by having the right materials for us at the right time."

"AZ has distinguished itself among our suppliers," Hartnett added.

The audit comprises two sections: Quality Potential and Quality Performance. The Quality Potential section accounts for 40% of the score and covers supplier business systems, quality systems, and technical support. The Quality Performance section makes up the remaining 60% and includes a site audit and production performance measures.

According to Harnett, the initial surveys sent to AZ were well answered with objective evidence of the quality and business management systems. The chemical materials team for wafer fabrication, which Hartnett heads, gave AZ the highest first-pass score ever recorded. The team was so impressed with the results that a site audit was planned for verification.

AZ did not disappoint them—ANADIGICS gave AZ Electronic Materials 14 commendations for safety, training, disaster planning, supplier management, manufacturing practices, and pricing. The site audit verified that a complete QS-9000 compliant system is in place and functioning properly.

Hartnett praised AZ for its quality culture, "It is evident that AZ Electronic Materials has gone beyond the intent of the spec and implemented a true quality management cultural change."

Founded in 1985, ANADIGICS pioneered the high volume cost-effective manufacture of high performance gallium arsenide integrated circuits. ANADIGICS is a leading worldwide supplier for the communications market. ▲

2004 Trade Show Calendar

- SEMICON Korea, February 18 – 20, Seoul, Korea
- SPIE's International Symposium on Microlithography, February 24 – 25, Santa Clara, California, USA
- SEMICON China, March 17 – 19, Shanghai, China
- SEMICON Europa, April 20 – 22, Munich, Germany
- SEMICON West, July 12 – 14, San Francisco, California, USA
- SEMICON Taiwan, September 13 – 15, Taipei, Taiwan
- SEMICON Japan, December 1 – 3, Tokyo, Japan

In the News

TEL and Clariant Establish Pattern-Collapse Suppression Process and Material

AZ Electronic Materials and Tokyo Electron Limited (TEL) have jointly developed a surfactant rinse solution and processes for the formation of ultra-fine patterns that are used in next-generation semiconductor production processes.

The surfactant rinse solution, trade-named FIRM, is intended to suppress "pattern collapse," a phenomenon in which the capillary effect causes photoresist patterns to collapse during development. This phenomenon can occur when the aspect ratio, defined as the ratio of photoresist film thickness to the width of a pattern, is three or greater, making it difficult to image ultra-fine photoresist patterns. The surfactant rinse solution reduces the capillary forces that cause pattern collapse, thus facilitating smaller photoresist patterns.

This new process is enabled through a simple modification of existing equipment and is being evaluated by major semiconductor manufacturers worldwide. Using the rinse process TEL has established its CLEAN TRACK™ equipment capable of 90 nm mass production. The process has been verified as extendible to 55 nm patterns.

AZ Electronic Materials is manufacturing the rinse solution, and TEL is marketing and providing rinse supply hardware and process optimization.

For further information, contact Tomo Hasegawa at Tomoaki.Hasegawa@Clariant.com. ▲

Visit our website www.azresist.com where you will find information about our product lines, news about AZ, and contact information.

In the News (continued)

AZ Achieves ISO/TS 16949:2002 Certification

AZ Electronic Materials once again leads the industry in quality management by becoming the first photoresist and related materials supplier to the semiconductor industry to become certified to the latest automotive international standard for quality management systems, ISO/TS 16949:2002, at its Somerville, N.J., facility. The company received registration from Quality Management Institute (QMI) in January 2004.

This standard supersedes the QS-9000 Quality System Requirements, to which AZ was also the first photoresist manufacturer in the industry to achieve certification in 2001.

The ISO/TS 16949:2002 standard is recognized by the automotive industry worldwide and includes all aspects of the QS-9000 requirements, the IS0 9001:2002 standard, and additional requirements addressing the complete supply chain management. Along with AZ's own compliance, AZ's suppliers' quality management systems must be developed to ensure the quality of raw materials purchased. Specific performance metrics are maintained for incoming material and AZ's processes and products. The overall result is a robust process for product design and development, production control and efficiency, reliable testing, and support of AZ's products.

"AZ's ISO/TS 16949:2002 certification assures our customers that AZ is committed to total customer satisfaction by having a quality management system that addresses the total supply chain," said Jitu Balar, quality director. "We have successfully demonstrated a consistent, continually improving quality culture. Achieving this certification is a major milestone in our continual improvement process, and we look forward to refining the process based upon the numerous metrics that are now an integral part of our quality management system." ▲


CERTIFICATE OF REGISTRATION

AZ ELECTRONIC MATERIALS

ISO/TS 16949:2002 - Second Edition

▲ *ISO/TS 16949:2002 certificate*

AZ Supports HOPE Worldwide

AZ Electronic Materials' Dallas office supported the local and global benevolent organization HOPE Worldwide for the third year in a row at its annual Golf Classic. HOPE Worldwide is a non-profit charitable organization in special consultative status with the Economic and Social Council of the United Nations. It provides health and safety support to urban children and their families. ▲

◀ *AZ supported HOPE Worldwide at its annual Golf Classic: (left to right) Brad Williams, AZ Eastern region Sales and Applications manager; Kenny Schuster, Director of Hope Worldwide, Texas; and Ron Eakin, AZ account manager.*

New Faces

AZ welcomes the following new and transferring employees:

Alberto Dioses has been promoted from internal applications engineer to field applications engineer based in Somerville, N.J. He supports 365 nm, 248 nm, and 193 nm technologies. He has worked at AZ for eight years and holds a B.S. in chemical engineering.

Dong-Kwan "Don" Lee has recently transferred to the 193 nm development team from the 248 nm development team. He joined AZ in Japan in 1999 where his last position was contact hole R&D project leader, and he transferred to the United States in 2002. Prior to joining AZ he worked for six years as a photolithography process engineer for a major IC manufacturer in Korea. Lee holds a B.S. in physics.

Dr. Peter Dürichen joins the Sales & Marketing team in Germany as senior applications engineer. His primary focus is on 193 nm and other advanced products. His educational background is in chemistry with emphasis on inorganic and solid state chemistry. Prior to joining AZ, he worked for a large manufacturer of ICs as a process engineer in production where he gained valuable experience in wafer track issues and defectivity in lithography. ▲

Product Focus

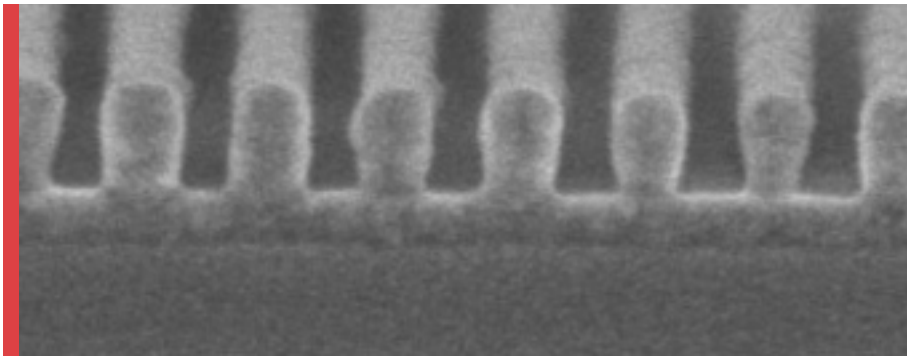
193 nm Immersion: The Next Node?

AZ leads with some of the smallest pure dense features ever printed

Advanced semiconductor manufacturers have started their initial resist selection process for the 65 nm node. This is considered to be the last technology node for 193 nm lithography. The question is now, "What is the next wavelength?"

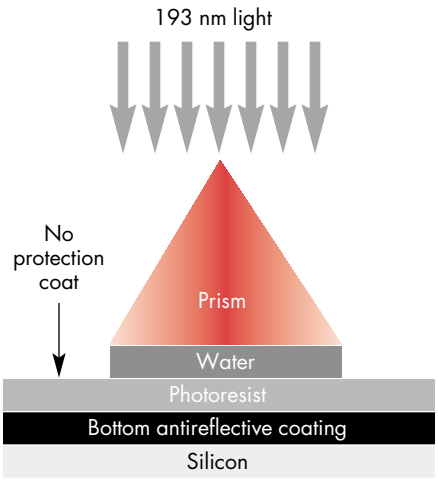
Originally it was assumed that 157 nm would follow on the roadmap. Its fluorine excimer laser offers a reasonably robust source. However, a host of issues has made its development troublesome: oxygen absorption, all CaF_2 optics, the absence of a robust soft pellicle material, CaF_2 birefringence, a lower efficiency excimer source, and of course the changes required to the photoresist platform. Expensive fluoropolymers or silicon-containing polymers are required as base resins. In addition, 157 nm photoresists are a magnitude more sensitive to amine contamination, requiring amine levels below one part per billion.

In 2002 Burn Lin of TSMC suggested that the industry should focus its efforts on what is now called 193 nm immersion lithography. It relies on the age-old concept of putting a higher refractive index liquid between the last optical element and the projected image to increase resolution. In immersion microscopy, oils are used to collect more light from the sample, therefore increasing the resolution capability of the system. For 193 nm lithography, a liquid with a higher refractive index than air at that wavelength allows for an NA greater than 1.0. Water is ideal: It is non-toxic, transparent, and has a reasonable refractive index of 1.43 as well as a low viscosity (to minimize drag on the scanning stage). But what about the photoresist?



▲ *45 nm lines and spaces, 90 nm pitch, 193 nm interferometric exposure at Nikon, HPLC water immersion, n sin θ ~ 1.07, 100 nm resist, 38 nm bottom antireflective coating thickness, AZ experimental immersion resist and no protection coat.*

193 nm Immersion Process



AZ's current results show some of the smallest pure dense features ever printed with 193 nm immersion using water and no protection coat—45 nm lines and spaces, i.e., 90 nm pitch!

AZ Electronic Materials was one of the companies invited to participate in an early Sematech 193 nm immersion task force that began work in December 2002. The conclusion is still not certain, but probable: There are no major showstoppers from the photoresist side. While the current 193 nm photoresist platforms will require some optimization for best performance under immersion, there will be no need to invent a new resist platform. AZ is working toward such optimized 193 nm immersion photoresists. AZ's current results show some of the smallest pure dense features ever printed with 193 nm immersion using water and no protection coat—45 nm lines and spaces, i.e., 90 nm pitch! ▲

NewsLines is published quarterly for members of the semiconductor industry by Clariant Corporation. Lisa Martin Altland, Marketing Communications Manager, Editor.

Clariant

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Dear Valued AZ Electronic Materials Customer,

The year 2004 is one of a lot of expectations, both for the industry as a whole and for our business in particular. After the industry went through a quite long and deep downturn over the last few years, there are now clear signs of a sustained recovery. Business started picking up in the second half of 2003, driven by a broad increase in chip demand. While some areas, especially business spending on information technology, are still slow, all indications are for a recovery of these areas in 2004 as well. Most products such as the new digital consumer electronics are still in the early life cycle, and the industry is not expected to be faced with excess capacity any time soon. We should expect a nicely improved business environment in the next few years.

In line with our long-term strategy to become a recognized industry leader, AZ Electronic Materials is well positioned for the years ahead. We have developed new competitive products, especially in the 193 nm area. Our development efforts are focused on tailor-made products to meet our customers' needs. This is underlined by enabling technologies such as our RELACS® shrinkage products and our solvent-developable bottom antireflective coatings. Our product line covers all lithography-related products and provides the needed expertise to address integration issues.

We put in place a state-of-the-art infrastructure, including a new manufacturing plant and functional testing facilities with 300 mm wafer capabilities. As part of the continuous improvement of our Quality Systems, we recently achieved ISO/TS 16949:2002 certification. Our product quality and order fulfillment systems are leading in the industry. The whole organization is focused on customer satisfaction, as demonstrated by fast response times as well as committed and focused support efforts. Our skilled Applications Engineering group is available to provide specific support to develop product and process solutions. Based on our strengths, we are looking forward to further broadening our business relationship in 2004 and helping you to succeed in your business.

Driven by events unrelated to our business, as already reported in the last *NewsLines* edition, Clariant has defined a new strategy focus and announced the sale of businesses including AZ Electronic Materials. The business will be sold as the entire global unit and has been offered to selected parties with a strategic interest in electronic materials. While it is not possible to be definitive at this stage, the sale process is well underway and the high interest shown for our business gives confidence that our new parent will be committed to continue supporting and growing all our activities. Clariant expects the sale to close in the first half this year, and we will keep you closely updated on the developments. In the meantime, Clariant continues to provide full support to our business to maximize its value. This includes all necessary investments for future product needs. In summary, it is ensured that business will "continue as usual" and that our high quality materials will continue to be delivered without any interruptions during the whole sale process.

On behalf of all AZ Electronic Materials' employees, I would like to thank you for your continued business and our close cooperation in exploring new product opportunities. I am very confident, that AZ Electronic Materials is a strong partner for you and will provide a shared competitive advantage.

As mentioned before, we will keep you updated on all developments. If you have any questions or concerns, please do not hesitate to contact me.

Yours sincerely,

Friedrich Herold
Vice President, AZ Electronic Materials

Review Technical Advancements at SPIE

AZ Electronic Materials is once again participating full force at SPIE's Microlithography Symposium February 22 – 27 at the Santa Clara Convention Center and Westin Hotel in Santa Clara, Calif. AZ will present its latest advancements in the papers and posters listed below, and will have an exciting new exhibit booth highlighting the latest photoresists and related resist-performance-enhancement products on February 24 – 25. Be sure to attend SPIE's BACUS Technical Group panel discussion co-sponsored by AZ, "193 nm Immersion before 157 nm Lithography—Another 'Vacation' for Mask Makers?" on February 24.

AZ's Technical Papers

RESIST MATERIAL ISSUES IN IMMERSION LITHOGRAPHY • **Evaluation of resist/liquid interactions for 193 nm immersion lithography** • W. Hinsberg, G. Wallraff, C. Larson, B. Davis, V. Deline, S. Raoux, D. Miller, F. Houle, H. John, L. Sundberg, IBM Almaden Research Ctr.; R. Dammel, Clariant Corp.; W. Conley, Motorola, Inc. and International SEMATECH [5376-03]
Monday, February 23, Session 2, 1:30 – 3:10 p.m.

157 nm MATERIALS • **Recent advances in fluorinated resists for application at 157 nm** • F. M. Houlihan, R. Sakamuri, D. Rentkiewicz, A. Romano, R. Dammel, Clariant Corp. [5376-14]
Tuesday, February 24, Session 4, 8:00 – 10:00 a.m.

RESIST FUNDAMENTALS II • **Study on the dissolution inhibition of poly norbornene hexafluoroisopropanol in aqueous base solutions** • M. A. Toukhy, J. Oberlander, D. Rahman, Clariant Corp. [5376-40]
Wednesday, February 25, Session 8, 8:00 – 10:00 a.m.

ARC/PATTERN COLLAPSE/DEFECTIVITY • **Optimization of photosensitive BARC and KrF resist for implant layers of 65 nm logic** • D. C. Owe-Yang, B. Ho, Taiwan Semiconductor Manufacturing Co., Ltd.; S. Miyazaki, T. Katayama, K. Susukida, W. Kang, Clariant (Japan) K.K.; Y. Chang, Clariant Taiwan Co., Ltd. [5376-48]
Wednesday, February 25, Session 10, 1:10 – 3:10 p.m.

IMMERSION LITHOGRAPHY • **Deep-UV immersion interferometric lithography** • A. K. Raub, S. R. J. Brueck, Univ. of New Mexico; W. Conley, Motorola, Inc. and International SEMATECH; G. Feit, International SEMATECH; A. Romano, Clariant Corp.; M. Sato, Tokyo Ohka Kogyo Co., Ltd.; B. Hinsberg, IBM Almaden Research Ctr. [5377-26]
Wednesday, February 25, Session 5, 8:20 – 10:20 a.m.

AZ's Technical Posters

The following poster papers will be displayed all day Monday, February 23 and until 1:30 p.m. Tuesday. Authors will be stationed at the posters for the formal poster session Monday evening between 5:30 and 8:00 p.m.

ARC • **Design and development of high etch rate organic bottom antireflective coating for sub-100-nm node and beyond** • S. S. Ding, Z. Xiang, H. Wu, A. Hishida, D. Abdallah, J. Shan, E. Gonzales, M. Neisser, Clariant Corp. [5376-81]

LER/PATTERN COLLAPSE • **Effect of the rinse solution to avoid 193 nm resist line collapse: a study for modification of resist polymer and process conditions** • S. Masuda, M. Kobayashi, Clariant (Japan) K.K.; W. Kim, C. Anyadiegwu, M. Padmanaban, R. R. Dammel, Clariant Corp.; K. Tanaka, Y. Yamada, Tokyo Electron Kyushu Ltd. [5376-105]

NOVEL APPLICATIONS/PROCESSING • **High temperature negative resist tunable for new lift off applications** • M. A. Toukhy, P. Lu, K. Kao, Clariant Corp.; C. Chen, Lumileds Lighting [5376-113]

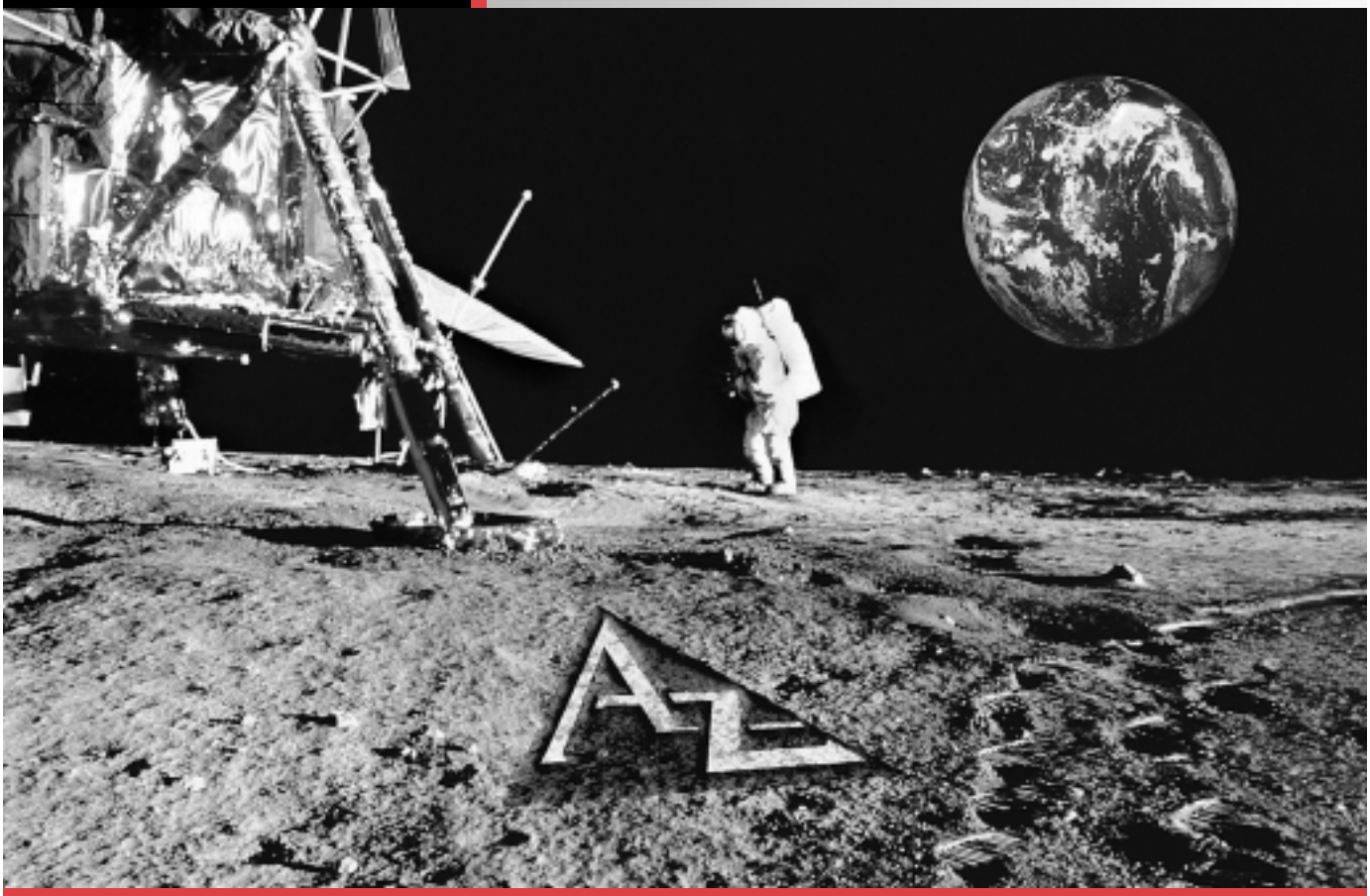
RESIST PROCESSING • **Acid diffusion characteristics of RELACS® coating for 193 nm lithography** • S. Hong, T. Nishibe, Y. Takano, H. Tanaka, Clariant (Japan) K.K. [5376-135]

PEB sensitivity studies of ArF resist (II): polymers and solvent effects • C. Hong, S. Lee, W. Kim, T. Kudo, A. Timko, D. Mckenzie, C. Anyadiegwu, D. Rahman, G. Lin, R. R. Dammel, M. Padmanaban, Clariant Corp. [5376-144]

The following poster papers will be open for observation all day Wednesday and Thursday. Authors will be stationed at the posters for the formal poster session Thursday evening between 5:30 and 8:00 p.m.

PROCESS OPTIMIZATION AND CONTROL • **Developable bottom antireflective coatings for 248 nm and 193 nm lithographies** • W. Kang, T. Katayama, H. Motobayashi, Clariant (Japan) K.K.; J. E. Oberlander, M. A. Toukhy, S. K. Mullen, S. S. Ding, M. Neisser, Clariant Corp. [5377-92]

MODELING, SIMULATION, AND ANALYSIS • **Modeling of photosensitive and non-photosensitive base-developable bottom antireflection coatings** • M. Neisser, Clariant Corp.; J. J. Biafore, Physical Simulation and Modeling, LLC; G. dela Pena, Univ. of Rhode Island; J. E. Oberlander, M. A. Toukhy, Clariant Corp. [5377-150]



NASA Photo

ONE SMALL STEP WITH AZ, ONE GIANT LEAP FOR YOUR LITHOGRAPHY.

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