member profile

Kanti Jain, founder of Anvik Corp.

Jain pioneered excimer laser lithography.

By Ginger Oppenheimer

If the progress in semiconductor devices is to be described in a few words, it would be "ever greater density and speed," according to Kanti Jain. Founder and CEO of Anvik Corp. (Hawthorne, NY), Jain is best known as the pioneer of excimer laser lithography.

"Greater density means more memory cells, transistors, or logic circuits per unit area," Jain explains. "Greater speed means faster logic function performance, faster memory access and retrieval, etc." That means there's a need to make devices of smaller and smaller geometries in producing each next generation of integrated circuits (ICs). "Of all the IC production tools, the lithography system is the most critical," Jain adds. "It is the great enabling technology—more than any other process tool, the lithography tool determines whether the next IC (e.g., a 4-Gb memory chip or a 2-GHz microprocessor) can be fabricated or not."

In the late seventies, the densest semiconductor devices (64-kb memory chips) were being made with a minimum feature size of 2.5 µm, all-optical lithography was done with mercury arc lamps, electron-beam (e-beam) lithography was considered and pitched as a viable production technology for high-density ICs, and x-ray lithography was beginning to draw the attention of advanced technology departments in many big companies.

Jain entered the field of microlithography in 1979. "The progress in microlithography in the last 20 to 25 years has been breathtaking," he says. " Personally, it has been exciting to have been a part of it."

"As we survey the scene now," he adds, "the smallest geometries are approaching 0.1 µm. Most leading-edge optical tools are excimer laser lithography systems. E-beam tools are primarily used for mask-making (certain critical levels). And x-ray lithography has not managed to prove itself as a viable production technology despite sizable worldwide investment—a few billion dollars, by some estimates.

"New types of lithography systems have been introduced to

Above: Kanti Jain, a pioneer in the field of excimer laser lithography, has been making his mark on the industry for more than two decades.

Left: This system by Anvik executes lithography on large, flexible sheets.

address new product applications," says Jain. "For example, large-area lithography tools are used for flat-panel display production, and roll-to-roll lithography tools produce flexible electronics for telecommunications products."

Jain has seen breathtaking changes in his career that have paralleled the impact of his invention of excimer laser lithography on semiconductor chips. After conducting research in nonlinear optical phenomena and optical switching devices at MIT, Jain moved to Hewlett-Packard (Palo Alto, CA), where he initiated a project to develop novel ultraviolet (UV) metal-vapor lasers and discovered several new laser transitions in the UV and infrared (IR) spectral regions. From there he moved to IBM, where, at the Almaden Research Center (San Jose, CA), he pioneered excimer laser lithography.

He moved on to several other positions at IBM, at both the T. J. Watson Research Center (Yorktown Heights, NY) and corporate headquarters (Armonk, NY). It was there that he furthered his drive to develop excimer laser lithography as an enabling tool (see sidebar on page 42).

The semiconductor industry widely acknowledges that excimer laser lithography tools are the best for microelectronics production. According to Jain, it's because they are the most cost-effective. They deliver high throughput and require less initial capital investment than other tools. "They provide the lowest cost of ownership," Jain says. "So far, they have been able to provide the necessary resolution. But as we approach and move below 0.1-µm features, changes may be anticipated."

more than chips

While semiconductor chips are the obvious beneficiaries of excimer laser lithography systems, numerous applications—including those in the high-growth telecommunications field—are enabled as well. Jain's company, Anvik is engaged in

continued on page 42

Richard Hoover goes "down under" for AOS and SPIE meetings

Australian Optical Society

In December, as SPIE President-Elect, I had the opportunity to visit Australia. It was my great pleasure to accept the invitation of Keith Nugent, President of the Australian Optical Society (AOS), to attend the AOS Annual Meeting in Adelaide.

The AOS Conference was held at Adelaide University and featured a diverse array of interesting papers at the cutting edge of optical science. The meeting was held in conjunction with the 14th National Congress of the Australian Institute of Physics. Consequently, in addition to many interesting AOS papers on x-ray microscopy, quantum communication, and quantum cryptography, I enjoyed the great diversity of other interesting talks available. These included a plenary paper on "The Origin of the Universe" by John Barrows and a stimulating evening lecture on "Time Travel" delivered by Paul Davies.

While at the AOS conference, I also had the opportunity to present a paper on my own research in search of "Evidence for Microfossils in Ancient Rocks and Meteorites." I was also fortunate to be able to spend a delightful afternoon with Paul Davies discussing his books and scientific papers concerning the origin and distribution of life in the cosmos.

While in Adelaide, Richard Powell (2001 President of OSA) and I attended a meeting of the AOS Council. This afforded me the opportunity to become better acquainted with the leadership of the society. We discussed cooperation between our organizations and mechanisms that may help AOS and SPIE to better serve members of the Australasian and International optics and photonics community.

We discussed the possibility of running SPIE short courses at AOS conferences; we also explored the desire to increase international participation in editorial roles in SPIE journals and ways to stimulate more extensive involvement of international members as SPIE conference and session chairs and members of program committees for SPIE conferences. During this meeting, I had the opportunity to discuss with the AOS leadership the extensive array of SPIE awards and educational scholarships and grants in optical science and engineering. I urged them to make sure their brightest and most talented students are aware of these opportunities and cognizant of the application and procedures.

smart structures and MEMS

I returned to Melbourne in time to participate in the SPIE- and the Australian Defense Science and Technology Organization–sponsored International Symposium on Smart Materials and MEMS. Papers at this meeting covered a wide range of topics; a plenary paper concerning the motility of microorganisms was of particular interest to my own area of research. I also found time to visit the small town of Murchison, Victoria, which was astounded by the explosions and rain of rocks when the Murchison fireball descended on 28 September 1969. I heard first-hand descriptions from eyewitnesses of the sights, sounds, and methyl alcohol smell that accompanied this dramatic meteorite fall.

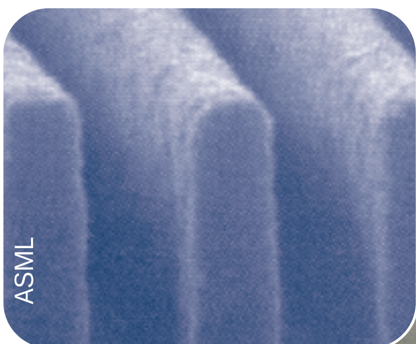
At the Victoria Museum in Melbourne, I was provided with a loan of several pristine samples of precisely documented specimens of the Murchison meteorite. These samples have been kept in tightly sealed vials since they were collected (immediately after the fall) and are of the greatest value to the study of chemical and morphological biomarkers and the search for evidence of biogenic activity and indigenous microfossils in carbonaceous meteorites.

If you have questions or comments for Richard Hoover, SPIE's 2001 President, you can contact him at richard.hoover@msfc.nasa.gov.

continued from page 41

the design, development, and manufacturing of advanced optical systems and equipment for diverse microelectronic, communication, and information technology applications. Systems include large-area lithography, via-generation, and materials processing tools for high-throughput production of communication electronics, flat-panel displays, opto-electronic systems, printed circuit boards, and flexible circuits.

Anvik's manufacturing equipment business is based on several breakthroughs



Above: A scanning electron micrograph of 0.13-µm images obtained on a KrF-excimer-laser lithography tool.

Right: Kanti and wife Vijaya Jain on the big island of Hawaii.

the company has made in optical systems, lithography, and microelectronics process technologies (the company's patent portfolio currently comprises 41 patents, 32 of which have been issued or allowed and 9 of which are pending). These innovations have enabled Anvik's production equipment to achieve the extremely high throughput levels and low cost of ownership demanded by the burgeoning telecommunication and information technology industries.

While many semiconductor companies benefit from being situated in the heart of Silicon Valley, Jain says Anvik's location in New York state is also advantageous. "There are several colleges with graduate programs in optics and precision engineering on the East Coast, which enables us to draw new employees with excellent, relevant skills."

He adds that companies in the area are generally more stable and employee turnover is less, which is due "partly to the greater mutual loyalty between a company and its team, and partly to the fact that more people here tend to settle down in a community." One disadvantage, he admits with a smile, is that interacting with West Coast companies becomes a long business trip.

away from work

Jain is married with two college-age sons. He has traveled widely: He has been to every state in America except North Dakota, nine countries in Europe, most of India, eastern and western Canada, and South America. For inspiration he reads books on great achievers and great enterprises. Jain says his family has a good library at home, and he sometimes reads books on religion and philosophy.

Music (mostly classical—both Indian and Western) is his passion, and he declares that "a six-CD changer in the car is a must!" Jain cites an array of favorite movies, including *Blade Runner*, *Papillon*, *Hoosiers*, *Amadeus*, and *Gandhi*. And to relax he takes long walks along the beautiful Hudson River.

Kanti Jain was elected Fellow of SPIE in 1993. He is the author of Excimer Laser Lithography, *published by SPIE Press in 1990 and reprinted in 1992 and 1999. He has served on SPIE's Board of Directors and has chaired and been a member of SPIE's Publication Committee. Jain has presented numerous papers and short courses at SPIE conferences and has served as cochair of SPIE's Microlithography Symposium.*

quality is a way of thinking

In 1982, soon after Kanti Jain published the first paper and gave the first talk on excimer laser lithography at SPIE's Microlithography Symposium, he clearly knew that excimer laser lithography would become a preferred technique for production lithography tools for IC manufacturing. While working at IBM, with the invention and the technology lead in hand, Jain pushed for the development of excimer lithography production tools. At the end of his tenure at IBM, it became clear that the company would not get into building manufacturing equipment. "IBM was a computer, software, and services company—not an equipment company," Jain explains. "I quickly recognized the soundness of this as a business decision from IBM's perspective. Since my driving desire was to develop and build excimer lithography systems, I set out on my own.

"It was a tough road," Jain admits. "I laid out the technical designs and business plan for building the most advanced excimer lithography tool—a quarter-micron system with a large field and high throughput. But I could not get the necessary financing (several tens of millions of dollars). The clear message I got from venture capitalists was that no matter how great the technology, they did not consider the prospects good for success for a start-up company in a field dominated by giants like Nikon and Canon."

Jain temporarily put his dream on hold. He worked at Raychem Corp. (Menlo Park, CA), where, as director of technology in the advanced packaging systems division, he managed programs in microelectronics packaging technologies. From this work, combined with his similar experience at IBM-Watson, he realized that the world of lithography and other patterning technologies was much larger than just ICs.

"Specifically," Jain explains, "I recognized that there was a real opportunity waiting for a new lithography company that could address the needs of a number of non-IC applications—large-format (but not submicron) patterning for microelectronic modules, flat-panel displays, and flexible electronics."

In 1992 he redirected the business focus for his future company. The combination of timely corporate partnering, government sponsorship, and private investment helped to launch Anvik.

Jain describes a personal conviction that he has woven into his business: "Quality is a way of thinking—a culture. I have tried to inculcate this in my team at Anvik. One of the phrases we don't use in our company is 'good enough.' It's lucky for us that our customers, sponsors, employees, and colleagues recognize this as a strength, and not as a fanatical obsession with perfection." *—G. O.*

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