



Notes from the Chair

It is my pleasure to introduce to you the candidates for this year's division elections. John Ekerdt and Molly Shoichet have been very active in the division, and have graciously agreed to run for the position of Second Vice Chair. The winner will be in line to become the First Vice Chair next year, and ultimately will help direct the division as Chair. Tim Anderson, Suriya Mallepragada and Giuseppe Palmese represent an excellent group of choices for the position of Director. The two winners will each serve two-year terms. I want to take this opportunity to thank each of them for volunteering their services. There is also an initiative on the ballot to hold our elections electronically. Please consider this proposal carefully.

I hope that you will take some time to read Dennis Hess' excellent article on "Materials and Interfacial Issues in Integrated Circuit Processing," that he presented for the Charles M.A. Stine Award Lecture at the MESD Plenary Session last year in Dallas. This year's plenary session proves to be equally exciting. I look forward to seeing all of you at the Annual Meeting in Los Angeles.

Sue-Ann Bidstrup Allen



Dennis Hess (right) receives the 1999 Stine Award from Jim Trainham of DuPont (left).

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Materials and Interfacial Issues in Integrated Circuit (IC) Processing

1999 C.M.A. Stine Award Lecture

Dennis W. Hess

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I am honored to have received the C.M.A. Stine Award from the Materials Engineering and Sciences Division of AIChE. MESD and DuPont, through this award, promote the importance of materials in areas of interest to members of AIChE. In this vein, I will present some background information on the importance of materials in current and future integrated circuit (IC) fabrication sequences. Within this overview, I will describe briefly some examples of research underway in our group.

The progression of the silicon-based semiconductor or IC industry has been phenomenal. In 1999, worldwide sales of semiconductor devices were more than 140B\$. When the industry began in 1959, there was one device on a chip – a transistor, with minimum feature size $\sim 70 \mu\text{m}$. Current state-of-the-art chips have more than 10^{10} components (transistors, resistors, capacitors, diodes, etc.) with minimum feature size 180 nm. By 2011, the minimum feature size will be 50 nm. In 1980, the cost of performing one million (arithmetic) instructions per second (mips) was $\sim \$500$, and device speed limited the number of mips to ~ 0.1 ; today, the cost of one mip is $< \$1$ and the circuits can perform 10^3 mips. The steady reduction in minimum feature size has allowed more and more components to be incorporated onto a single chip of

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silicon, at ever decreasing cost. This decreasing cost per function (Moore's Law), has provided an almost insatiable drive to use ICs in an ever expanding array of applications. Individuals uncomfortable with the increasing sophistication and capability of succeeding generations of computers often wish for simpler, less intricate computers. These individuals wonder why they are unable to purchase computers with the capabilities and sophistication of those sold in the early 1980s. The fact is, such computers are available – they are in toasters and microwave ovens.

The basic building block for many of the ICs manufactured is the metal-oxide-semiconductor (MOS) transistor shown as a simple schematic in Fig. 1. The silicon substrate is p-type silicon (boron-doped), while the source and drain regions are heavily doped ($>10^{18}$ dopant atoms/cm³) n-type (phosphorus- or arsenic-doped) silicon.

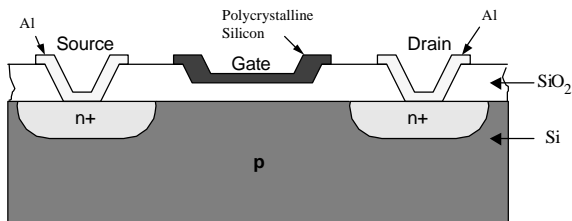


Figure 1 Schematic of the MOS Transistor.

The layers above the silicon surface are SiO₂ films, while the regions designated source, gate, and drain are conducting films, shown here as aluminum (source, drain) and polycrystalline silicon (gate). The source/drain conductors allow voltages to be applied to the n-type regions, while the gate conductor permits a voltage, and hence an electric field, to be applied across the gate dielectric (SiO₂ in this case). When a negative voltage is applied to the source, and a positive voltage to the drain, current can flow across the gate if a sufficiently positive (threshold) voltage is applied to the gate. This voltage attracts electrons to the p-type silicon surface to complete the conduction channel. The minimum feature size referred to in this discussion is the gate length, or the distance between the source and drain regions; this represents the distance that an electron must travel during transistor operation. The smaller the distance to be traveled, the greater the device speed.

Materials research and development has been an integral part of the evolution of microelectronic devices and ICs. However, the current and future need for new materials is unparalleled in the history of the semiconductor industry. Since the inception of the industry, certain film materials continue to be used extensively: Si (generally doped with B, P, or As), silicon dioxide, boron- and phosphorus-doped silicon oxides, silicon nitride, and aluminum (often Al alloys with Cu and/or Si additives). Little change in the materials cadre occurred from 1960 until the mid-to-late 1970s (2-3 μm feature size). From that time on, essentially one new material was introduced for every new device generation, which was approximately every three years. For instance, from ~1980 until the present, refractory metals (e.g., Mo, W) and various silicides such as TaSi₂, WSi₂, often in conjunction with polycrystalline Si, were used as the gate conductor, TiW or TiN were introduced as contact and barrier layers between metals and the silicon substrate, silicon oxynitride and polyimides have been invoked as dielectric or isolation materials between layers of metal, and most recently, copper has been implemented as an interconnect material. The relatively infrequent introduction of new materials in IC process technology is about to change drastically. The following discussion highlights some particularly interesting problems facing the IC industry over the next 5-10 years. Patterns are generated in thin films by a process called lithography. This process, shown schematically in Fig. 2, represents the most repetitive and critical process sequence in IC manufacturing; at least 20 lithographic operations are currently used in the fabrication of a state-of-the-art circuit. Lithography is performed by first spin-casting a film of a radiation (typically UV light) sensitive polymeric material termed a resist, onto a substrate. Typical resist formulations are comprised of a polymeric resin and a photoactive compound (PAC). Selective irradiation of the resist results in chemical changes to the PAC and/or resin such that the exposed regions can be dissolved away relative to the unexposed regions (positive tone photoresist),

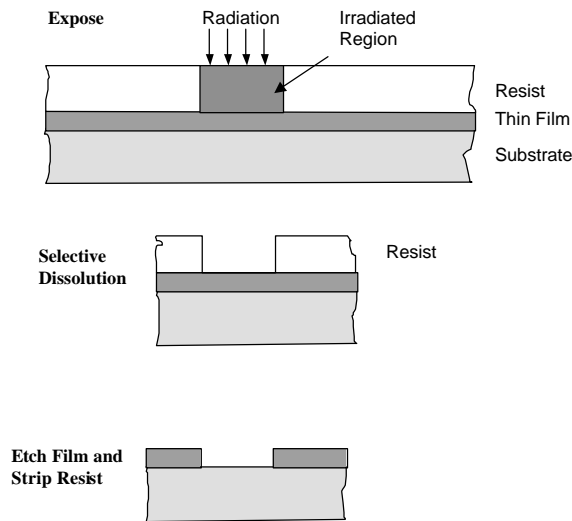


Figure 2 Lithography Process for Generating Patterns in Thin Films.

thereby generating a pattern or stencil in the film. This stencil is then used as a mask so that the film beneath the regions where the resist was removed are etched, while the remaining resist layer “resists” etching, thereby protecting the underlying film during a plasma etch process. Subsequently, the resist is removed (again by a plasma process), the next film layer deposited, and another lithography/etch sequence executed.

The continuous reduction in feature sizes that has led to the progression of the IC industry has been accompanied by a reduction in the wavelength of light used to expose patterns in lithographic sequences. The dominant resist materials over the past 40 years have been comprised of novolac (resin) and diazonaphthoquinone (PAC). Unfortunately, as the exposure wavelength is reduced below 300 nm, the high opacity and the low sensitivity of novolac-diazonaphthoquinone systems prevent their continued use. Therefore, new resist materials are being introduced for 248 nm and 193 nm exposure. Typical resins for the new resist formulations are poly(hydroxystyrene) derivatives, while the PACs are photoacid generators such as sulfonium or iodonium salts. As the exposure wavelength continues to decrease, development of other resist material formulations will be required. In fact, as the exposure wavelength falls below 200 nm, the strong absorption of UV light by organic

materials may eliminate the use of conventional lithographic materials and processes. Furthermore, if the resist is thick (>500 nm), and fine-line patterns (<180 nm) must be etched, high aspect ratio features result. Because of these issues, new resist materials and “surface imaging” methods are of considerable interest. We are investigating the development of surface-initiated patterning processes and materials for direct micro- and nano-scale lithographic patterning. For instance, an initiator monolayer like $\text{SiCl}(\text{CH}_3)(\text{CH}_2)_2(\text{C}_6\text{H}_4)(\text{N}=\text{N})\text{C}(\text{CN})_2\text{CH}_3$ can be attached to a hydroxylated surface. Subsequent selective irradiation with UV, X-ray, or e-beams will activate the initiator. Exposure of the stenciled initiator layer to a monomer initiates polymerization only at the active initiator sites. Although this forms a polymer layer, this layer must be resistant to the plasma atmosphere used to perform the subsequent etch step. Because the resist layer must be thin, high etch resistance is needed. We have been developing monomers that, after surface polymerization, can undergo elimination and aromatization in a thermal, photochemical, or chemical consolidation step. This permits the in-situ formation of carbon-based rings or aromatic structures that are sufficiently robust to withstand plasma etch processes.

Prior to the current device generation (1 GB), the factor determining device speed was the gate length of the transistor. However, with more than 1 billion components on a chip, the primary limitation on circuit speed is now the time required to transmit signals between devices/components. This is referred to as delay time, and is dependent on the electrical conductivity of the metal (conductor) and the dielectric constant (k) of the insulator isolating the various conductor patterns. Copper is favored over aluminum for interconnections, because Cu offers a gain of a factor of ~ 2 in conductivity. Also, the capacitance of dielectrics used to isolate metal layers affects device speed, cross-talk between the metal lines, and power consumption. As a result, a low value of capacitance, and thus insulators with low dielectric constants, are desired. The primary dielectric used since the industry began is SiO_2 , with $k \sim 4$. The specific low k approach(es) to be adopted is (are) still unclear, because no single material has been found that meets all the requirements for a low k

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film; requirements include mechanical strength, dimensional and thermal stability, ease of pattern definition, high thermal conductivity, and ability to be integrated into existing process sequences. As a result, a variety of materials are being investigated to achieve k values between 2-3, including fluorinated organic and inorganic materials, aromatic hydrocarbons, SiCOH (carbon doped glasses), porous oxides (silsequioxanes, nanoglasses), and multiphase materials (e.g., SiCOH-hydrocarbon mixtures). Ultimately, approaches that permit $k=1$ will be desired; of course, this represents the lowest possible dielectric value, possibly achievable via air gaps in the device structures.

Because teflon has a dielectric constant of ~ 2 and is chemically inert, fluorocarbon materials have been of significant interest as low k candidates. However, these materials are currently unable to withstand elevated temperature ($>350^\circ\text{C}$) processing without degrading. Recently, we have been investigating the use of plasma-assisted CVD to deposit cross-linked fluorocarbon films at temperatures between $120^\circ\text{-}240^\circ\text{C}$ from C_2HF_5 and C_4F_8 monomers. The combination of elevated substrate temperature and plasma-assisted deposition should result in a fluorocarbon network that exhibits improved thermal stability relative to room temperature depositions. Films deposited from C_4F_8 display higher F/C ratios and thus lower k values (2.18-2.33, depending on the deposition conditions) than films from C_2HF_5 (2.23-2.55). Thermal degradation of the polymer films is similar for both monomers below 300°C ($\sim 1\%$ weight loss). However, films deposited from C_4F_8 exhibit higher decomposition rates above 300°C . Analyses indicate that as deposited, these films have a lower extent of crosslinking than do films deposited from C_2HF_5 , due to differences in deposition rate and F scavenging by H. In addition, dehydrofluorination, which is prevalent during heat treatment in films formed from C_2HF_5 , does not occur in C_4F_8 films, since little H is present. Dehydrofluorination stabilizes the film by forming conjugated double bonds; this suggests that a small amount of H might be advantageous when choosing fluorocarbon monomers for low k films.

Due to device scaling issues, a reduction in feature size also requires a reduction in film

thickness. As a result, high k (again, relative to the SiO_2 standard of 4) films are needed both as gate dielectrics to avoid the high tunneling currents that result from the use of thin (<1.5 nm) SiO_2 gate insulators, and as capacitor materials to minimize the bit cell area needed for capacitance requirements. High k materials for capacitor applications may be needed by the 130 nm device generation (~ 2002). The most likely initial choice for this application is CVD tantalum oxide, with $k\sim 25$. However, other materials such as TiO_2 , barium-strontium-titanate (BST), lead-zirconium-titanate (PZT), or strontium-bismuth-tantalum (SBT), will likely be required by 2005; BST, SBT, and PZT films have k values of 100-1000.

One of the most challenging requirements for dynamic random access memories (DRAMs) beyond the 100 nm generation is the development of a high k gate material. It is conceivable that silicon oxynitride might meet the demands until gate dielectric thicknesses ~ 1.2 nm are reached around 2005, but even so, other materials will be required shortly thereafter. Although several materials such as Ta_2O_5 and BST have been investigated, they continue to suffer from thermal and interfacial instability and process integration issues. The perovskite crystal structure of materials such as BST must be established in order to obtain high k values. Typically, this is achieved by post-deposition annealing at high temperatures ($>600^\circ\text{C}$) under oxidizing conditions. This process requirement imposes severe limitations on the selection of electrode (conductor) materials that are compatible with such process sequences. For instance, the conductors may need to withstand the oxidation environment and should not remove oxygen from the high k film due to thermodynamic or kinetic driving forces, or changes in film properties can result. Either noble metals (e.g., Pt), or conductive oxides (e.g., iridium oxide, ruthenium oxide), are choices for these electrodes; of course, integration of such materials into standard fabrication processes for ICs is a major concern for both gate structures and capacitors. Furthermore, post-deposition heat treatments in oxygen result in oxidation at the high k/Si interface to form a thin layer of SiO_2 .

(continued on page 7)

Materials and Engineering Sciences Division Elections

Please carefully review the candidate profiles that follow and then vote according to the instructions on the enclosed ballot. Failure to follow the instructions will result in an invalid ballot and vote. A return envelope is provided. Please return your ballot no later than September 29, 2000. Ballots postmarked after this date cannot be tabulated.

Profile of Candidates for Second Vice Chair

John G. Ekerdt received a B.S. in Chemical Engineering from the Univ. of Wisconsin and his Ph.D. from the Univ. of California, Berkeley. He joined the faculty at the Univ. of Texas at Austin in 1979 as an Assistant Professor and is now the Z. D. Bonner Professor and Department Chair. He also serves as the Associate Director of the NSF Science and Technology Center for the Synthesis, Growth and Analysis of Electronic Materials. His major research thrust has been the materials chemistry of thin films for electronic and photonic devices. His work has ranged from the design and synthesis of organometallic precursors with tailored physical and chemical properties for compound semiconductor and multimetal film growth, to the surface chemistry of silicon and its alloys, to the design and growth of barrier films. His work seeks relationships between the interface and surface reactions and the performance and characteristics of the films. In addition to his activities with AICHE he has been an active member of the American Chemical Society, the North American Catalysis Society, Council for Chemical Research and the American Vacuum Society. Within AICHE he has edited the Chemical Engineering Faculties Directory, served as Chair of the Balcones Fault Section, and was Meeting Program Chair for the 1991 Houston National Meeting.

John has been active in MESD, initially organizing and chairing sessions and recently as Program Chair for Area 8E. He believes MESD is a critical programming group within AICHE since it exemplifies interdisciplinary themes that are resonating throughout industry, government and academe. As Programming Committee Chair, and ultimately MESD Chair, he will work to promote and advocate the central role of materials in society, to increase programming opportunities for materials within AICHE, and to expand the activities of the Division through cooperation with other AICHE Divisions and other societies.

Molly Shoichet received her S.B. in 1987 from MIT and her Ph.D in 1992 from the University of Massachusetts, Amherst in Polymer Science and Engineering. Molly worked in biotechnology (at CytoTherapeutics) from 1992-1995 and joined the University of Toronto in 1995 where she is now an Associate Professor in the Department of Chemical Engineering and Applied Chemistry. Molly has combined her fundamental training in polymer science with her experience in neuroscience to develop a biomaterials research program focussed on neural tissue engineering. Molly's research group: designs and synthesizes new polymers for biomedical applications; creates new 3-dimensional structures for tissue engineering applications; and examines different mechanisms of axonal guidance using surface modification and drug delivery techniques. Ultimately, Molly aims to combine this fundamental research into a device to enhance axonal regeneration following spinal cord injury. Molly has published over 100 papers, patents and abstracts, serves on the international editorial board of Biomaterials, has served as guest editor for two special tissue engineering issues and organized several special symposia on tissue engineering, including those at the Materials Research Society and the Society for Biomaterials. At AICHE, Molly has been active in the biomaterials subgroup (8b), serving as vice chair and chair during 1996-2000. During her tenure as chair, 8b has increased its profile at AICHE, co-sponsoring sessions with 15d/e, 1b, among others. In 2001, we anticipate having more co-sponsored sessions than in previous years. As vice chair, Molly will continue to promote co-sponsorship between MESD and other areas to continue the trend started with 8b. This will serve to highlight the importance of materials to chemical engineering. With an active research group in both polymers and biomaterials, Molly is ideally situated to serve as 2nd vice chair.

Profile of Candidates for Position of Director (Vote for two)

Tim Anderson received his education in chemical engineering from Iowa St. Univ. (B.S. 1973) and the Univ. of California, Berkeley (M.S. 1975, Ph.D. 1978). He is currently professor and chairman of the Chemical Engineering Dept. at the Univ. of Florida where he has been on faculty since 1978. His current research efforts are devoted to the study of advanced electronic, photonic, and composite materials processing. His group has an active program in the growth of group III nitrides for visible light emitting devices. His research interests range from flow visualization in low Pr fluids, to using gas phase laser spectroscopies to measure homogeneous thermal decomposition rates of organometallic precursors. Recently, his group has been using novel single source precursors to grow barrier materials, in addition to developing alternative processes to grow CuInSe_2 absorber layers for thin film photovoltaics. Tim has been recognized for his research accomplishments through such awards as the ICEE Commemoration Medal (1999), the AIChE Gary L. Leach Award (1996), the AIChE Charles M. A. Stine Award, (1994), the Cal Tech W.N. Lacey Lectureship (1993), and the Professional Progress in Engineering Award by Iowa St. Univ. (1993). Tim also spent his last sabbatical at the University of Grenoble as a Fulbright Senior Research Scholar. Professor Anderson is editor of the *Chemical Engineering Education* journal and associate editor of the *Journal of Phase Equilibria*. Tim has long been active in AIChE, in particular MESD. He was a founding member of Area 8e, serving as chair from 1991-1993, and subsequently as chair of the Division from 1994-1995. He has served as a member of a number AIChE committees including the Research and New Technology Committee, the Executive Board of the Program Committee (Chair), and the Alliance of North American Chemical Engineers (ANACHE) formation committee. Tim is currently a member of the Chemical Engineering Technology Operating Council. He believes his long and broad involvement in AIChE, as well as other materials-related societies will allow him to provide sensible advice to the Division.

Suriya Mallepragada received her chemical engineering education from IIT Bombay (B.Tech, 1993) and Purdue Univ. (Ph.D., 1996), and was a post-doctoral fellow at MIT. She joined the faculty of Iowa State University in 1996 where she is currently an Assistant Professor of Chemical Engineering. She has adjunct appointments in the Biomedical and Materials Science and Engineering departments at Iowa State University. She is also an Associate Scientist at Ames Laboratory, a federal laboratory, and is a member of a DOE Center for Smart Polymers. She has been a visiting researcher at several universities including the Univ. of Parma, Italy, Univ. of Naples, Italy, Rice Univ. and Izmir Institute of Technology, Turkey. Her research interests are in biomaterials, specifically in drug delivery and tissue engineering. Her work involves synthesis and micro and nanopatterning of polymeric materials to create surfaces that can be used to control and modify cell behavior and transport properties. She has published over 35 articles and presented numerous invited lectures. She is the recipient of many awards including the NSF Career award. She

is actively involved in several societies including AIChE, ACS, APS, MRS, Tau Beta Pi and Sigma Xi. She has chaired several sessions at AIChE, ACS, and AIChE-ASME Bioengineering conferences. She is chairing a symposium on Biomaterials for Drug Delivery at the fall MRS meeting this year. She is also currently serving as treasurer of the ACS Ames section. As director, Surya would work to: continually enhance the visibility of MESD within AIChE; balance various areas and promote interdisciplinary programming initiatives with other divisions of AIChE as well as with other societies; continue to increase membership and meeting participation of researchers, especially from industry and federal laboratories through new programming initiatives and by improving the relevance of meeting publications; and promote diversity and student participation in MESD activities.

Giuseppe R. Palmese received his chemical engineering education from Princeton University (B.S. 1986) and the University of Delaware (Ph.D. 1992). Giuseppe's interest in the science and engineering of polymeric materials initiated during his undergraduate education when he worked with Professor John K. Gillham. His Ph.D. work, advised by Professor Roy L. McCullough, focused on the chemical and physical behavior of thermosetting polymer systems at interfaces in composite systems. Between 1992 and 1994 Giuseppe gained industrial experience developing polyolefin technology for the production of highly amorphous ethylene-propylene copolymers. Subsequently, he became a research scientist at the Center for Composite Material of the University of Delaware where he developed a strong research program focused on the study of reacting polymer systems. In addition Giuseppe served as Assistant Director of the Center for Composite Materials and as a Research Professor in the Materials Science and Engineering Department from 1998 to 2000. Giuseppe has recently taken the position of Associate Professor in the Department of Chemical Engineering at Drexel University where his current research interests include radiation curing of polymers, tailoring interfaces in composite materials, the control of thermosetting polymer behavior characteristics via the manipulation of polymer nanostructure, and nanocomposites. Giuseppe has over 50 publications and has been awarded three U.S. patents. In addition he has given numerous invited talks to gatherings including the Gordon Research Conference and the National Materials Advisory Board. Giuseppe has been an active member of the MESD division for the past 6 years. During this time he has chaired and co-chaired numerous sessions and has been the Program Chair or Program Vice-Chair for Area 8f for the past three years. As MESD Director Giuseppe will pursue opportunities to expand the role of MESD in AIChE through expanded programming and greater collaboration with other Divisions. Moreover he will work to broaden membership and to ensure the breadth of MESD programming in the coming years.

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This process reduces the effective k of the gate stack due to the addition of a lower k film (SiO_2) in series with the high k dielectric. Unfortunately, the presence of a thin SiO_2 or SiON layer at the Si interface may be necessary to reduce leakage currents and ensure electrical and chemical stability of the gate. Materials such as ZrO_2 and HfO_2 , or their alloys with SiO_2 , are promising candidates for gate materials, although the time required to develop processes and solve integration problems may be significant.

In addition to the concerns associated with the deposition of new film materials, plasma-assisted etching and resist removal present challenges for both low k and high k materials. The plasma etch behavior (rate, anisotropy, selectivity to underlying films) of low k materials depends critically on the film composition and density. Si-containing films with reasonably high C content are sometimes etched with fluorocarbons (e.g., CF_4 , CHF_3) or mixtures of these gases that do not contain oxygenated species, since preferential removal of C changes film properties. Etching of pure organic materials is often performed in O_2 -based plasmas, although H_2/N_2 mixtures or NH_3 have been used despite the lower etch rates compared with O_2 -based gases. Post-etch reliability of low k materials is a concern, since high diffusion rates of etchant species such as F can be expected in porous layers. Plasma-assisted etching of high k materials is problematic because elements such as Ba, Bi, Sr, Pb, etc., have few volatile compounds that can be formed easily in a plasma atmosphere. Therefore, elevated temperatures ($>100^\circ\text{C}$) with high ion bombardment flux are needed to desorb etch products from the surface. Similarly, conductors such as Pt and RuO_2 are difficult to etch. For both dielectric and conductor etch processes, resist layers capable of withstanding the severe plasma conditions are needed. After completion of an etch process, the protective resist material is removed. Typically, this is performed by an O_2 -based plasma, followed by liquid chemical treatments (e.g., hydroxylamines, *n*-methylpyrrolidone) to remove any organic or inorganic etch process residues, extensive de-ionized water rinses to ensure cleanliness, and wafer

drying. High plasma removal rates generally require temperatures $>150^\circ\text{C}$; C moieties in the low k material are thus attacked, causing an increase in k value and increased film stress. Such concerns have led to the use of reducing plasma chemistries (H_2 , N_2/H_2) to strip post-etch resist layers. Although the removal rate is lower than that observed with O_2 -based approaches, the low k films appear stable to these reducing plasmas.

Large quantities of DI water are needed in rinse cycles after resist removal and surface cleaning/modification; currently, ~ 2000 gallons of water are used to process a single 200 mm wafer, and this consumption is expected to double by 2003. Our group has been investigating new approaches to reduce the amount of DI water used, and to reduce or eliminate the use of corrosive post-etch chemical treatments. One method of lowering water use is to consolidate the resist removal, DI rinsing, and drying operations. Preliminary results suggest that this may be possible by using elevated temperature ($<100^\circ\text{C}$), elevated pressure fluids such as various alcohols or water. After the removal process, pressure reduction flashes the liquid from the surface, leaving a dry surface for the next (vacuum) process step. Similarly, we have been investigating the use of supercritical CO_2 with and without additives such as water to perform resist removal.

I hope that the brief discussion of some materials issues and concerns in current and future IC fabrication processes demonstrates the important role to be played by the materials engineering community over the next 5-10 years. Since IC process technology is comprised of a series of chemical processes, chemical engineers are poised to play a critical role in the development of novel materials and related processing methods. Success in these endeavors will ensure a continuation of the extraordinary advances and enhanced performance that have become trademarks of microelectronic devices and ICs.

Again, I want to express my sincere appreciation to MESD and DuPont for sponsoring the C.M.A. Stine Award. I also thank my colleagues in MESD for supporting my nomination and for many stimulating conversations and collaborations over the past 15 years.

Cohen Named Stine Award Winner

Robert E. Cohen, Raymond A. and Helen E. St. Laurent Professor of Chemical Engineering at MIT, has been named the recipient of the 2000 Charles M.A. Stine Award. This award, sponsored by DuPont, is the division's highest award. His 220 publications and 10 patents reflect interests in polymer structure/property relations. He maintains a program of synthetic polymer chemistry to support the structure/property work.

Bob Cohen was born and raised in Oil City, Pennsylvania, an environment which led to an early interest in the discipline of chemical engineering. He studied at Cornell Univ. (BS) Caltech (MS and PhD) and Oxford Univ. (Postdoc) prior to joining the MIT faculty in 1973. He has served as Director of MIT's Program in Polymer Science and Technology and a Associate Chair of the MIT Faculty. Currently, he chairs the Committee on the Graduate Program in Chemical Engineering, and co-directs the DuPont/MIT Alliance on bio-based materials.

Bob has been active in AIChE activities, including service as a Chair of Polymer Programming and a Director of the Materials Division. He served as a consulting editor for the American Institute of Physics book series on Polymers and Complex Fluids, currently serves on the editorial advisory boards of several polymer science journals, and is North American editor for the Journal of Polymer Engineering. At MIT, he has received DuPont, Edgerton and Bayer faculty awards. He was a recipient of a Dreyfus Teacher Scholar Award and has presented numerous named lectures including the Robert W. Vaughan Memorial Lecture at Caltech and the Shell Distinguished Lectureship at Northwestern.

Based on a set of patents produced in his laboratory on the topic of polymer surface modification, he co-founded MatTek Corporation in 1985. He has served on the board of trustees of the Advent School in Boston and Kiser Research, Inc., in Washington, D.C. He is currently a member of the board of directors of the William and Mary Greve Foundation in New York City and MatTek Corporation in Ashland, MA. Bob lives in the city of Boston with his wife and two children.

Upcoming Meetings

2000 AIChE Annual Meeting

November 12-17, 2000
Los Angeles, CA

2000 MRS Fall Meeting

November 27 - December 1, 2000
Boston, MA

Pacificchem 2000

December 14 - 19, 2000
Honolulu, Hawaii

International Conference on Advanced Ceramics & Composites

January 21-26, 2001
Cocoa Beach, Florida

2001 AIChE Spring National Meeting

April 22-26, 2000
Houston, TX

50 Year Members Honored

National recently recognized all 50 year members of the organization., including two MESD members: Hollis (Tom) Galley and Alex James. Mr. James is the CEO of Alex James & Associates, Inc. and works in Greenville, SC. We received a letter from Mr. Galley, an excerpt from which follows:

"I spent five years obtaining a BS in Chemical Engineering from Kansas State University – supporting myself working in a drug store for 25¢/hr. On graduation I was employed by Eastman Kodak in the Paper Service Division of their Paper Manufacturing Division at Kodak Park. I specialized in adhesives, dyes, non-silver photographic processes, 'instant photography', and the manufacture of photo-inert board products from photo-inert waste papers. I have some 20 patents. I was chairman of the Rochester AIChE for 1 year. I operated two out-of-the-basement businesses for 30+ years. They prospered in direct proportion to the time I could spend with them. After retiring and selling the businesses my wife and I moved to our home on the island of SABA, Netherlands Antilles."

The Division extends its congratulations to Tom and Alex.

Annual Meeting MESD Events

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
8:30 AM	<p>[198] Biomaterials I Grande Ballroom Salon 4 - Marriott</p> <p>[209] Biosensors San Gabriel A - Westin (15d, 15e)</p> <p>[184] - Diffusion in Polymers and Membranes I; San Pedro - Westin (2d)</p> <p>[201] New Ceramic Membrane Materials Room 106A - UCLA (with 2d)</p> <p>[183] Structure and Properties of Polymers I San Gabriel B - Westin (1a)</p>	<p>[181] MESD Plenary Session Avalon - Westin</p> <p>[307] Characterization of Biomaterial-Host Interaction San Gabriel B - Westin (15)</p>	<p>7:00 AM MESD Programming Meeting; Room TBA</p> <p>[190] Thermodynamics of Polymers II San Pedro - Westin (1a)</p> <p>[192] Solids Handling in the Polymer Industry Room 109 - UCLA (3c, T1)</p> <p>[191] Polymer Thin Films and Interfaces II Room 208 - UCLA (1a, 2d)</p> <p>[210] Plasma Processing I Avalon - Westin</p>	<p>[204] Advances in Ceramic Processing Los Cerritos - Westin</p> <p>[200] Functional Biomaterials Santa Anita C - Westin (15d, 15e)</p> <p>[196] Polymer Processing and Rheology I Board Room Lounge - Marriott</p> <p>[212] Transport Phenomena in Electronic Materials Processing San Diego - Westin</p> <p>[64] Innovations in Materials Engineering San Gabriel B - Westin (T3, 4)</p>	<p>[214] Chemical Vapor Deposition San Diego - Westin</p> <p>[215] Molecular Simulation of Material Processes I; San Pedro - Westin (1a)</p> <p>[207] Novel Catalytic Materials Board Room Lounge - Marriott</p> <p>[207] Novel Catalytic Materials Board Room Lounge - Marriott (20)</p> <p>[125] Semiconductor Surface Chemistry II, Grande Ballroom Salon 3 - Marriott (1)</p> <p>[273] Applied Mathematics, Simulation, and Modelling in Chemical Engineering Santa Barbara A - Westin (10)</p> <p>[260] Control of Microelectronic Manufacturing Processes San Bernardino - Westin (10)</p>
2:00 PM	<p>[202] Advances in Ceramic Membranes Room 106A - UCLA (2d)</p> <p>[199] Biomaterials II Grande Ballroom Salon 4 - Marriott</p> <p>[186] Diffusion in Polymers and Membranes II; San Pedro - Westin (2d)</p> <p>[185] Structure and Properties of Polymers II; San Gabriel B - Westin (1a)</p> <p>[7] Nanostructured Materials and Particles Santa Barbara A - Westin (T1, 3)</p>	<p>[203] Nanostructured Materials Room 109 - UCLA (3d)</p> <p>[188] Thermodynamics of Polymers I San Pedro - Westin (1a)</p> <p>[187] Structure and Properties of Polymers III, Novel Characterization San Gabriel B - Westin (1a)</p> <p>[189] Polymer Thin Films and Interfaces I Room 208 - UCLA (1a, 2d)</p> <p>MESD Executive Committee Meeting; Room 303 Marriott</p> <p>5:30 PM Area Programming Meetings, TBA</p>	<p>[211] Plasma Processing II Avalon - Westin</p> <p>[194] Thermodynamics of Polymers II San Pedro - Westin (1a)</p> <p>[193] Polymerization Kinetics, Catalysis and Reaction Engineering San Jose - Westin (20)</p> <p>[195] Polymer Thin Films and Interfaces III Room 208 - UCLA (1a)</p> <p>4:30 PM [182] Poster Session: Materials General Session; Pasadena Room - Westin</p>	<p>[206] Applications in Sol-Gel Derived Materials Los Cerritos - Westin</p> <p>[219] Composites Processing II Avalon - Westin</p> <p>[205] New Ceramic Absorbent Materials for Gas Separations San Pedro - Westin (2e)</p> <p>[197] Polymer Processing and Rheology II Board Room Lounge - Marriott</p> <p>[213] Reaction Kinetics in Electronic Materials Processes San Diego - Westin</p> <p>[124] Semiconductor Surface Chemistry Grande Ballroom Salon 3 - Marriott (1)</p> <p>[313] Biomimetic Materials Santa Anita C - Westin (15)</p>	<p>[208] High Temperature Non-Catalytic Reacting Systems Concourse Ballroom Salon 3 - Marriott (20)</p> <p>[216] Molecular Simulation of Material Processes II San Pedro - Westin (1a)</p> <p>[217] Reactor Design and Analysis for Electronic Materials San Gabriel B - Westin (20)</p> <p>[220] Cure and Degradation Kinetics San Diego - Westin (20)</p>

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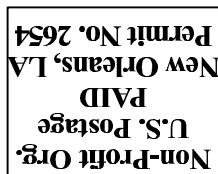
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