THE chemist®

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A Declaration...

It is fitting during this Bicentennial Year of 1976 that we, as Chemists, bring to the attention of our peers and Society, the debt we owe to our dedicated scientists. If their work had not been done, the world would be different and would not exist in its present form. In the forefront of the scientists is the chemist; It is to the latter that the following pages are dedicated.

The Chemical Pioneer Award is given to chemists whose ideas and research have brought significant benefit to mankind and have expanded the frontiers of knowledge and technology. Our understanding has been immeasurably broadened by their efforts. The age of the chemist and his previous recognition has little or no bearing on the selection of the awardee. What is sought is the selection of the person who is accomplishing worthwhile work, and demonstrating to the world original contributions that chemists are making in shaping the future, chemists who are continuing their innovative and creative work as well as those who, for the first time, are carrying out outstanding significant novel research.

Pioneers initiate things, but their accomplishments come to fruition only through the cooperation and support of numerous associates. Each AIC Chemical Pioneer, whose accomplishments are recorded in this special Bicentennial Issue has requested that we provide this credit line in behalf of their associates, and it is my privilege to do so.

—Alex P. Mathers, President
American Institute of Chemists

SPECIAL BICENTENNIAL ISSUE

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Volume 53, Number 4

AIC Chemical Pioneers: Gifts to Society

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O. A. Battista

"for pioneering research in the colloidal chemistry of high polymers." (Awarded 1969) Employer at time DISCOVERY: FMC Corporation

Dr. Battista

Commercial plants to manufacture the first microcrystal polymer product invented by Dr. Battista—microcrystalline cellulose—now are realities in the United States, Japan, and Northern Ireland. Patented microcrystalline celluloses are used in numerous foods, (low-calorie foods, salad dressing, etc.), pharmaceuticals (tabletting), and industrial products (paints, catalysts) with tens of millions of pounds sold to date.

Another major invention of Dr. Battista and his associates to achieve commercial stature is Avitene Hemostat. The New Drug Application for this product has recently been approved by the FDA for marketing in the United States. As a safe and outstandingly effective anti-bleeding agent, it proffers to be of great humanitarian value as a new major adjunct for surgery. It is a natural form of collagen which is especially effective in stopping bleeding in internal organs and it is completely assimilated by the body in a matter of a few weeks.

Other members of the microcrystal polymer family that have been researched and are awaiting future development are derived from amyloses, chrysotiles, polyamides, polyesters, polypropylenes, wool, and silk. Each of these also has considerable future potential in performing special services to society and in providing security ► for hundreds, even thousands of families.

Following 32 years in industry as a research scientist (62 U.S. Patents, over 450 foreign patents, 35 scientific publications), Dr. Battista retired in 1974 as Vice President, Science and Technology, Avicon, Inc., to become a consultant and to enter academe. He is Director of the first center of its kind formed to pursue research and teaching in the field he has pioneered; Center for Microcrystal Polymer Science at the University of Texas at Arlington.

In addition, he now serves as Chairman and President, Research Services Corporation, is President-Elect of the American Institute of Chemists, has authored 17 books, (including the McGraw-Hill Treatise on "Microcrystal Polymer Science") and is Founder of The Olympiads of Knowledge Foundation.

Herbert C. Brown

"for pioneering achievement in the chemistry of boron, including the hydrocarbon reaction regarded as the most valuable synthetic organic tool discovered in the 20th Century." (Awarded 1975) Employer at time of DISCOVERY: Purdue University

Forty years ago, at the University of Chicago, under the direction of the late Professor H. I. Schlesinger and his research assistant, Anton B. Burg, Dr. Brown observed that diborane rapidly reduces the carbonyl group of aldehydes, ketones, and esters. His discovery made little impact on the chemical world—diborane was then a chemical rarity, synthesized only with great labor in milligram quantities.

This situation was altered by World War II. Interest in uranium borohydride led Schlesinger and Dr. Brown to the discovery of sodium borohydride and to practical methods for its manufacture, as well as to the discovery of its utility as a reducing agent for organic compounds. Sodium borohydride is now being manufactured on a large scale by the Ventron Corporation. The chemical is used as a source of diborane, as a reducing agent in the pharmaceutical field, and to remove mercury and other heavy metals from effluents. Perhaps its greatest potential is in the manufacture of paper pulp, *where its use solves a major ecological problem.*

It was later discovered by Dr. Brown that sodium borohydride can be used to convert olefins into organoboranes (hydroboration) in an economical and simple manner. They make possible stereospecific syntheses in the pharmaceutical and fine chemical area. At the present time, reduction by diborane and hydroboration is being utilized in the synthesis of hundreds of fine chemicals.

Borane chemistry also offers promise of providing new economical routes from paraffins to alpha-olefins, linear alcohols, and numerous other petrochemicals. This new area of technology awaits exploration. Thus, one pioneering development, sodium borohydride, has been manufactured in well over a million pounds and is widely used in industry. The second major development, hydroboration, is in the early stages of development and promises to become a major synthetic route for fine organic chemicals. Further down the line is the application of this new technology in the petrochemical area. ■

Dr. Brown

Rachel Brown

"for the discovery of the fungal antibiotic "Nystatin" which is an important help to physicians and a boon to mankind." (Awarded 1975) New York State Department of Health

Dr. Rachel Brown

The discovery of Nystatin by AIC Chemical Pioneers Rachel Brown and the late Elizabeth L. Hazen, made available the first safe antifungal antibiotic for human therapy. It proved to be a boon for the treatment of certain candida infections such as thrush and vaginitis and for the correction of disordered intestinal flora caused by broad spectrum antibiotics. Apart from human therapy, it is also incorporated in veterinary vaccines and is used to prevent a fatal fungal infection in turkeys.

Due to its fungistatic and fungicidal properties against a wide variety of fungi *in vitro* there are many non-medical applications of Nystatin. For example, it has been used to treat bananas before shipment, and as a feed additive for livestock. When art treasures were damaged by floods in Florence, Italy, moldy growths were successfully controlled with the drug. A recent very significant use is the successful treatment of American elm trees which are infected with the Dutch elm disease.

The antibiotic was discovered and described at the Division of Laboratories and Research of the New York State Department of Health where there was no policy for handling patents or royalties. Under these circumstances the expertise of Research Corporation was sought. The rights to the patent were assigned to them and an exclusive license to develop and manufacture Nystatin was awarded to E. R. Squibb and Sons. The royalties were divided *equally* between Research Corporation and the Brown-Hazen Fund, both for the support of scientific research.

The use of these royalties, in excess of $13,000,000, demonstrates how fruits of research can be applied to the support of further research. Although most of the grants were modest, they have often launched a young investigator on his career, or given another young person the necessary academic experience for subsequent research. In this sense, Chemical Pioneers Brown and Hazen have blazed an example of humanitarian concern that shines with the splendor of the noblest of human virtues—monetary unselfishness!

The Brown-Hazen Fund's support for training took many forms, such as an International Symposium on Medical Mycology, remodeling of the mycology laboratories of the College of Physicians and Surgeons of Columbia University, the publication of Hazen and Reed's Laboratory Manual for Identification of Pathogenic Fungi, and a number of special short term courses for physicians and technicians and postdoctoral exposure to laboratory and clinical problems.

Herman A. Bruson

"for outstanding pioneering research in industrial organic chemistry which has done much to elucidate the complex chemistry of dicyclopentadiene and has resulted in many valuable industrial contributions in the fields of oil additives, surface active chemistry, antioxidants, and plasticizers, reported in more than 500 U.S. patents." (Awarded 1966) Olin Mathieson Corporation

AIC Chemical Pioneer Dr. Herman A. Bruson was working on polymers of higher alkyl methacrylates during the mid-1930s. He found if he put some of these polymers in ordinary motor oil, the oil would stay about the same thickness or viscosity when it was subjected to extreme heat or extreme cold. In writing up his patent, Dr. Bruson, an artillery reserve officer, mentioned that the treated oil could be useful as a recoil oil for big guns. A Commander Earl of the U.S. Naval Laboratories saw the paragraph and ordered some for evaluation by the military. Dr. Bruson recalls he had to complete the order in his lab.

A short while later Russian tanks were becoming immobile because of the extreme cold. They asked their allies for aid, and the U.S. Army called on Dr. Bruson to prepare more of his special oil. As a result, the Russian tanks could move when the Nazi tanks were immobile, and the rest is history. In fact, every motorist has since been aided by that patented chemical. It is what makes possible one grade of oil for all weather. Subsequent chemical innovations by AIC Chemical Pioneer Herman Bruson have been equally significant and prolific—dyes for polyester fibers, heat-resistant polyester coatings, unique non-ionic surfactants, non-migratory plasticizers.

Dr. Bruson proffers sage advice to budding scientists based on his experience: "(1) Invent something to fill a specific need; (2) Invent something for which there is no known present need, but for which the invention itself is valid enough to warrant a patent that may be of value for future products; (3) Take a known patent and work around it, thereby developing one that's better." ■

Dr. Bruson

Melvin A. Cook

"revolutionized the civilian explosives industry by producing a family of materials which are cheaper, safer and more powerful than dynamite." (Awarded 1973)


Dr. Cook

A major advance in commercial blasting by virtue of their lower cost, far greater safety, and amenability to on-site bulk mixing and loading methods, slurry explosives were pioneered by Dr. Cook. They are being manufactured and loaded in bulk by methods faster, safer than heretofore possible.

Slurry Explosives ("slurries") are thickened and cross-linked or gelled aqueous ammonium nitrate (and other soluble oxidizers) mixtures in which are dispersed or dissolved suitable sensitizing fuels, the aqueous solution phase being at least enough to fluidize the mixture. There is a variety of slurries, each characterized by the particular fuel sensitizer employed. Dr. Cook's earliest inventions included aluminized slurries, coarse TNT slurries, and solid hydrocarbon (gilsonite)-sulfur-sensitized slurries. Later developments included fuel-oil-emulsion-sensitized slurries and soluble explosive-sensitized slurries, e.g., methylamine nitrate (MMAN), and glycol mononitrate (EGMN).

The types of slurry most extensively used today are the nonexplosive-sensitized ones, particularly the aluminized, solid and liquid hydrocarbon, and the soluble explosive (MMAN and EGMN) sensitized slurries.

Today the major slurry thrust is in replacement of dynamites in small-diameter applications by the polyethylene-packaged, cap-sensitive slurries. The duPont Company has announced its intention of replacing dynamite by slurry by 1980. Slurry explosives are also important from the environmental viewpoint. Indeed, their major components (inorganic nitrates) are valuable fertilizers. The extensive transition to the modern blasting agents in the late 1950's and 1960's was fortunate because the older explosives (dynamites, TNT, and other high explosives) have serious environmental disadvantages such as those relating to the disposal of "spent" acids and other contaminants.

Gerald J. Cox

"for his part in the discovery and application of dietary fluoride in the prevention of dental caries." (Awarded 1970) University of Pittsburgh

Serendipity guided Dr. Cox into the field of fluoridation of water. While at Mellon Institute on a fellowship involving a study of a relationship of cane sugar to dental caries, mottled enamel in the incisor teeth of rats was observed. Dr. Cox and his associates tried to produce mottled enamel in the molar teeth by water with 10, 20 and 40 ppm fluorine, using female rats as the test animals during pregnancy and lactation. Fortunately, as a convenience, they put the offspring on a caries producing ration at weaning at 21 days, just as the molar teeth were beginning to erupt. This meant that there was no direct contact of the water with the teeth. When these rats were sacrificed, their teeth showed no significant evidence of mottled enamel, and they were practically free of any carious lesions. At this point, Mary L. Dodds, Dr. Cox's associate, said "Maybe fluoride is *good* for the teeth."

In 1939, Dr. Cox called Western Pennsylvania Section of the American Water Works Association (AWWA) planning its annual meeting in Johnstown, Pa. He was put on the program to propose fluoridation of water. His idea was generally rejected but his paper was published in the AWWA Journal. On the last page was published a statement attributed to the AWWA Secretary, advising that water works engineers "must await widespread professional support before expanding the scope of their activities." Publishing a paper in a 1940 issue of the Journal of the American Dental Association, Dr. Cox discussed fluoridation of community water supplies to develop caries-resistant teeth. This was followed by an editorial taking an adverse position to this new idea.

Today, there are nine states in America that require municipalities to fluoridate their water supplies. As of the end of 1975, the American Dental Association estimated that over 100,000,000 people are being served by fluoridated water supplies—about one-half the entire U.S. population. ■


Dr. Cox

Carl Djerassi

"for brilliant research leadership in the complicated, difficult and highly important field of steroids and their derivatives." (Awarded 1973) Syntex, S. A.

Dr. Djerassi was the first person to perfect the chemical synthesis of an oral contraceptive, norethindrone, for treatment of menstrual and other gynecological disorders, and as an oral contraceptive. Details of the synthesis of this new drug were first reported by Djerassi and colleagues in 1952, when it was pointed out that this was the most potent orally effective progestational compound synthesized to date. The subsequent application of these findings stimulated research in many U.S. laboratories and in Europe.

In spite of the fact that several other compounds have been introduced into medical practice, even in 1976 probably more than half of the oral contraceptives used in the world contain norethindrone as the biologically active constituent. This is especially true of lesser developed countries (including the People's Republic of China).

The impact of oral contraceptives in the last 15 years has been world wide. First accepted in the affluent countries, largely because they are highly effective, they have had a well-known impact on population growth rates, social mores, and on women's increasing independence because of the greater ease in controlling their own fertility.

It is ironic that this chemical development which has had such a major impact on the world's population—both in terms of behavioral and numerical consequences—has led to drastically increased regulatory restrictions by agencies such as the FDA. The consequence is that development times for new contraceptives are now estimated to take at least 15 years. As a result, relatively little work is currently going on in the development of new oral contraceptives.

Dr. Djerassi

Thus the very early contraceptives, of which norethindrone is prominent, have continued to occupy an important share of the world market and presumably will continue to do so.

There is concern about the potential long term side effects of oral contraceptives, notably in terms of their possible involvement with breast or cervical cancer. Since norethindrone has been taken by more women for longer periods of time than any other oral contraceptive, epidemiological results associated with the long term use of oral contraceptives will be particularly meaningful with norethindrone. The development of oral contraceptives is not only of significance in the field of human fertility control, but it represents an excellent example of the promise as well as the difficulty in creating drugs that will be used in preventative medicine for many years in normal population groups.

C. H. Fisher

"for creative and inspiring leadership in pioneering research that led to the development of a new specialty rubber and the establishment of a new industry based on its manufacture and use." (Awarded 1966) U.S. Department of Agriculture

AIC Chemical Pioneer C. H. Fisher's contributions were primarily as a leader-catalyst who steered the efforts of a competent team of chemists in producing a new industry.

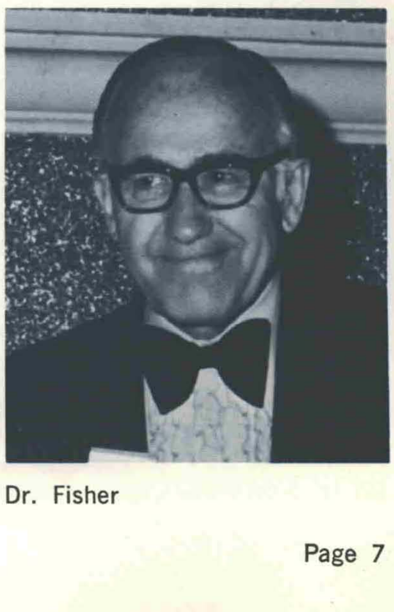
For some 30 years, polyacrylate rubber has contributed to the well-being and affluence of millions of consumers by providing excellent oil and high-temperatures resistance, combined with good physical properties.

Today nearly all automobiles contain some polyacrylate parts because this polymer has unusual resistance to: temperatures from −40° to 400°F., oxidation at normal and elevated temperatures, aliphatic solvents, ozone at normal and elevated temperatures, and gas permeation, e.g., hydrogen and helium.

Polyacrylate rubber has the additional advantage that its principal intermediates, alkyl acrylates, can be made from either petroleum or low-cost carbohydrates. In the 1940's, a small group in USDA's Eastern Regional Research Laboratory, Philadelphia, demonstrated the technical and economic feasibility of making methyl lactate from fermentation lactic acid. This group (C. H. Fisher, W. C. Mast, E. M. Filachione, W. P. Ratchford, C. E. Rehberg, and M. L. Fein) developed improved methods for pyrovinyl chloroacetate and allyl glycidyl acrylic esters.

Polyacrylate rubber has been improved by several developments, including the use of monomers such as vinyl chloracetate and allyl glycidyl ether to provide crosslinking sites, n-butyl and similar alkyl acrylates to lower brittle temperatures, alkoxyalkyl, cyanoalkyl, and cyanothiaalkyl acrylates to decrease oil swelling; and improved compounding formulations. Today polyacrylate rubber polymers are manufactured in many countries and estimates of annual production range from several million to about 18 million pounds.

Following 40 years as a research scientist (72 U.S. patents and about 150 publications) in the U.S. Department of Agriculture, U.S. Bureau of Mines, academia, and industry, Dr. Fisher retired to become consultant and Adjunct Research Professor at Roanoke College, Salem, Va. "Hap" Fisher has served the profession of chemistry in many ways, including that of AIC President, and subsequently AIC Chairman of the Board. ■



Dr. Fisher

Paul J. Flory

"for pioneering discoveries and original concepts regarding high polymers which have benefited both users and manufacturers of these materials." (Awarded 1973)

Dr. Flory

Professor Paul J. Flory received his AIC Chemical Pioneer Award two years before his selection as Nobel Prize winner in 1975. His fundamental work on polymers—which he began as a member of the famous team headed by the late Wallace H. Carruthers, father of synthetic polymer chemistry—has been of outstanding value, both to manufacturers and to users of a wide range of polymers, including fibers, plastics and rubbers. In particular, he pioneered original concepts about the molecular behavior of polymer molecules in solution, and their architectural structures, when they aggregate to produce useful properties and products of far-reaching value to society. His "contributions to polymer chemistry have fundamentally changed the aspect of that field. . . . Many of the earliest and most thorough measurements concerning the physical chemistry of high polymers were published by Dr. Flory and his co-workers. And much of existing precise thermodynamic data on polymer solutions is credited to them."

"Dr. Flory and Thomas G. Fox were the first to point out the importance of 'excluded volume' in the interpretation of the properties of a polymer chain in dilute solution. Excluded volume is a term that expresses the impossibility of two segments of a chain's occupying the same space. Such an idea may seem obvious, but its effects aren't so obvious. Dr. Flory's work also makes possible the determination of characteristics of dissolved polymer chains from simple measurements such as viscosity, sedimentation, ► and diffusion. For example, his theories permit calculation of the osmotic or light scattering behavior of a polymer solution entirely from hydrodynamic measurements."

Professor Flory's contributions are many and well-known. A comment of his, upon receiving his AIC Chemical Pioneer Award may not be so well-known, and this is a fitting place to repeat it.

"I would completely refute the notion that polymers, because they are molecules comprising many atoms, are complicated. They have their simplifying features, if one takes the trouble to find them, and I daresay this may be true of any subject,—that 'complicated' and 'simple' are subjective judgments—all is in the point of view. . . ."

H. Tracy Hall

"for his role in the synthesis of diamonds which resulted in the creation of a new industry." (Awarded 1970) General Electric Research Laboratory

The first laboratory synthesis of diamond from graphite by H. Tracy Hall some 20 years ago quickly led to the commercial production of diamond grit. His invention of the first machines capable of simultaneously generating high pressures and temperatures sufficient for the task coupled with "diamonds made by man" stimulated world-wide research that has vastly improved diamond materials available to industry.

Domestic production of diamond grit now stands at about 25 million carats per year with foreign production probably somewhat less. The total dollar value of this diamond is about $75 million. The manufacture of the product employs only about 1,000 people worldwide but many more are employed between the production of the raw diamond material, its fabrication into products such as diamond grinding wheels and its sale to the end user. Also, many services and products are used by the manufacturer.

The United States does not have any diamond mines and in the past has depended on other countries for its needs. The commercial production of synthetic diamond grit has relieved the U.S. of a former strategic disadvantage. However, for diamond grit sizes above 25 mesh and for drilling stones, the U.S. still depends on foreign supply. But research will soon change that. Sintered diamond powder and recrystallized diamond powder available in large shapes for cutting tools, wire drawing dies, etc. are new developments in which Dr. Hall has also pioneered. At least two companies are currently marketing these new products and they are proving to be superior in many ways to the natural diamond formerly used.

Continued innovation in the types of diamond produced by man is a certainty and a necessity. Known reserves of natural industrial diamond will not be able to supply the anticipated demands of the year 2000, and by that date Dr. Hall's contributions to the diamond industry will prove to be even more far reaching than they are today. ■

Dr. Hall

William E. Hanford

"for pioneering research in fluorochemicals, telomers, di-isocyanates, acetylene chemicals, and high polymers; for important contributions to the chemical profession and careers of fellow chemists; for outstanding leadership in industrial chemistry, exemplified by some 150 patents; and for creative inventions in the development of polyethylene, fluorine containing polymers, and polyurethanes." (Awarded 1967) Olin Mathieson Corporation

Dr. Hanford

Dr. W. E. ("Butch") Hanford has demonstrated much more than the creative laboratory results that qualified him to be selected as an AIC Chemical Pioneer; he also has been a top-level executive-philosopher in his time. Among his favorite quotes are, "The reason that science has been able to flourish so much during the past 50 years is due to our willingness to communicate our results to each other," or "Just like the pioneers of the past, nothing happens unless the settlers move behind the pioneers. Christopher Columbus and Daniel Boone would not have been anything unless the settlers moved in to develop what these pioneers had uncovered."

For example, Plunkett discovered Teflon and, as such, was a pioneer, but he could not bring it to the stage where the settlers could move in behind for exploratory work. Dr. Wylie, Dr. Joyce, and Dr. Hanford worked at this product to see if they could not develop it to the next stage. Dr. Wylie fabricated the first Teflon sheet and proved that the material was capable of being converted into a uniform useful product. Dr. Joyce developed an economical process for its initial manufacture.

Once these two men completed this work, the properties could be determined and its potential usefulness easily established. They were ready for the settlers to move into this new area in chemistry. These settlers have developed thousands of uses for the product. Since this material was introduced, it has helped us to get into space and, from the home point of view, over five million pieces of cookware have been converted into easy-to-clean equipment. And the plumber uses it every day in making his joints to improve the art of joining pipe; and the doctor, in human arteries. The list is endless and the settlers of the future will continue to expand this new class of products.

Dr. Hanford in cooperation with Dr. Chris also helped to develop what is now known as the urethane industry. Once the basic work was established, again the "settlers" were able to move in and develop the whole host of products now classified as flexible and rigid urethanes.

Rowland C. Hansford

"for pioneering research in catalysis leading to a improved hydro-cracking process capable of converting four gallons of low-grade crude oil to five gallons of gasoline with simultaneous lowering of the content of nitrogen, sulfur and oxygen." (Awarded 1976) Union Oil Company of California

Dr. Hansford's pioneering research has led to a process, named Unicracking, the first hydrocracking process to employ a new catalyst based on an important class of solids known as molecular sieve zeolites or more broadly, crystalline aluminosilicates.

Because of the superior activity, selectivity, and longevity of the original and subsequent generations of zeolite catalysts, developed by Dr. Hansford and associates, the Unicracking Process has enjoyed outstanding commercial success since the first plant went into operation in 1964. Its use is expanding, particularly into the field of petrochemical naphtha production, where its selectivity and high yields of light gasoline boiling-range products are essential. The first plant is still using some of the original charge of catalyst in converting low grade cracking stocks entirely to gasoline. Special catalyst regeneration procedures have been developed. It is now common to run for three years on difficult feedstocks without regeneration; some plants have run for more than six years before regeneration of the catalyst became necessary.

Because of the exceptionally high yields of refined products from stocks, which are difficult to convert efficiently by other means, hydrocracking plays a significant role in conservation of our petroleum resources. It does this in effect by reducing the amount of heavy fuel oil produced in the refinery and producing more gasoline and jet fuels. For some uses, such as power generation, heavy fuel oil can be replaced by coal, and thus its equivalent can be diverted to gasoline and other transportation fuels (jet and diesel).

The upgrading of low grade gas oils to high yields of refined transportation fuels represents a considerable economic benefit to the country. In 1976 the Unicracking Process will convert nearly 400,000 barrels of feed per day to refined fuels and petrochemical naphtha. The estimated yearly retail value of these products is about $4 billion, including excise taxes to state and federal governments. About 50,000 barrels per day of additional capacity will come on stream in 1977.

The future of hydrocracking with zeolite catalysts appears to be quite secure. Not only will there be expansion in the production of gasoline and other transportation fuels, but the future seems particularly bright for new plants to produce petrochemical naphtha and lighter hydrocarbons. ■

Dr. Hansford

Henry B. Hass

"for pioneering research in gas chromatography and in the preparation and chemistry of hydrocarbons, acetylene chemicals, and sucrose derivatives; for outstanding leadership in research, teaching, and the advancement of the chemical profession; and for creative inventions leading to the commercial production of glycerol, allyl compounds, amyl alcohols, cyclopropane, nitro-paraffins, chorinated hydrocarbons, and nitro polymers used as rocket propellants." (Awarded 1967) Pullman Kellogg Corporation


Dr. Hass

Dr. Henry B. Hass has earned a special niche in the annals of AIC Chemical Pioneer Award winners. He has served as Chairman of the Award Committee and Chairman of the Award presentation programs for many years, as well as President of the Institute. His talented and gracious performance in all of these capacities, and his steadfast adherence to the principle of searching for and selecting awardees for their unique contributions—irrespective of their past notoriety or lack of it—has made possible recognition of many chemists whose contributions never may have been pinpointed otherwise.

It was in the thirties that Dr. Hass and the late Dr. Earl T. McBee began studying the chlorination of the simple alkanes, then so abundant that vast quantities were being vented to the air. The literature on this subject was confused and contradictory because inadequate analytical methods had been used to characterize the chlorination products. The then recent invention of efficient laboratory rectification columns enabled them to bring order out of chaos and summarize their results in the form of ten or a dozen simple rules. In order to study the effect of temperature on the isomeric ratios of products they preheated hydrocarbon and chlorine, mixed them at a high-pressure jet to prevent burning at the point of entry of the chlorine and carried out the highly exothermic reaction under nearly isothermal conditions.

Shell researchers had discovered how to make glycerol from allyl chloride which could be produced in good yield by the high-temperature chlorination of propylene but had been unable to devise means for scaling the process up. After hearing Dr. Hass' lecture on jet chlorination, they tried it on propylene and it worked the first time. Commercial production soon followed.

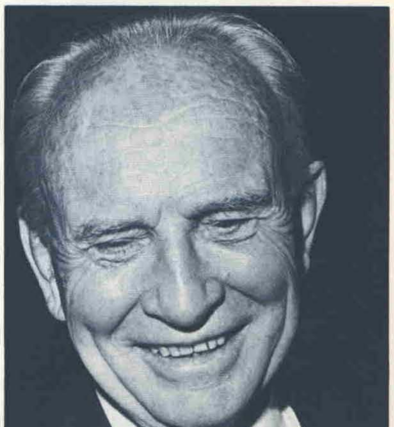
With his students, Dr. Hass discovered and named the reaction called chlorinolysis which is hydrocarbon chlorination with fission of a carbon-carbon bond. Much CCl_4 and C_2Cl_4 are made thus. When they tried this reaction on dichloropentanes it gave hexachlorocyclopentadiene which led to the Hetron resins of Hooker Chemical Corporation.

This know-how subsequently proved valuable to the Manhattan Project. The Oak Ridge gaseous diffusion process required C_8F_{16} which they made by chlorinating the methyl groups of xylenes. HF treatment converted the product to CF_3 groups. These stabilized the molecules and enhanced the yield of C_8F_{16} while decreasing the requirement for elemental fluorine which was the bottleneck in the process. This shortened World War II.

When asked what he believed was his most important single effort, Dr. Hass refers to the vapor-phase nitration unit process, an invention that involved Hodge and Vanderbilt as associates. This process led to the establishment of a new industry that still is going strong. It made available nitroethane by the nitration of propane, a process which is the starting point for the synthesis of the propellant for the Polaris missile. It has been said that Polaris submarines have done more to prevent major wars than all the diplomats combined, and that is still another contribution to the better life for which millions owe a respectful "thank you" to Dr. Henry Hass and his coworkers.

Sterling B. Hendricks

"for pioneering discoveries in photoperiodism, for the discovery and isolation of phytochrome and for a lifetime of distinguished service to this nation. (Awarded 1971) U.S. Department of Agriculture

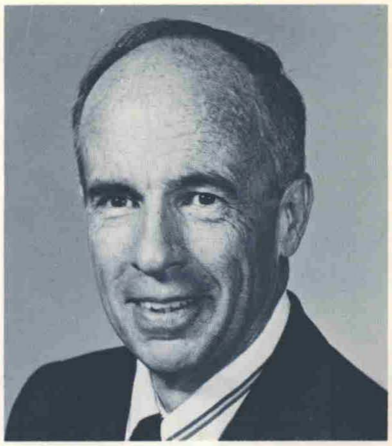

Dr. Hendricks

The blue chromoprotein phytochrome which Dr. Hendricks and his associates first recognized by studying the dependence of flowering plants on the seasons, and later its isolation, has now been established as one of the main factors regulating the growth and development of plants. The regulation results from the photo conversion in the red part of the spectrum of two specific forms of the chromophore of the protein. Phytochrome action is now established as being one of the main factors in the adaptation of plants to the environment.

Some of the plant responses in which phytochrome is involved are: (1) the time of flowering, (2) the germination of seeds, (3) the lengthening of stems, (4) the movement of leaves, and (5) the dormancy of buds. The degree of phytochrome action varies in plants and with seasons. Today, this variation is one of the factors used in selecting crop plants such as soybeans and sorghum for cultivation in particular areas. This has been a most significant chemical discovery that has made lasting contributions to improved agricultural output of selective stable crops—adding to the better quality of many segments of society. ■

C. C. Hobbs

"for pioneering achievements in the understanding and predictive controls of the liquid-phase oxidation of the simpler alkanes resulting in increased yields of liquid products, improved process economics and a saving of valuable hydrocarbons." (Awarded 1974) Celanese Chemical Company



Dr. Hobbs

Butane chemistry provided AIC Chemical Pioneer, Dr. C. C. Hobbs, with the original challenge that led to a process known as liquid phase oxidation (LPO). It has had far-reaching impact on the economics of hydrocarbons.

During the recent business recession, the nation was faced with marketing requirements for butane LPO products which required process improvements.

One of these improvements was the development of a catalyst for one system which permitted substantial savings in plant equipment requirements and attendant capital expenses.

Dr. Hobbs now projects that continuing improvements of these developments will be of great importance in permitting the use of still scarcer resources of hydrocarbons to help meet our energy needs. ■

J. Paul Hogan

"for being the creative root of the Phillips process for making high-density polyethylene and the copolymers of ethylene with other olefins, one of the great technological accomplishments of this century." (Awarded 1972) Phillips Petroleum Company

More than half of all high density polyethylene produced throughout the world is based on discoveries made by J. Paul Hogan and co-workers of Phillips Petroleum Company. He is inventor or co-inventor of more than 30 patents relating to the discovery and to later refinements of various grades of this versatile, high quality plastic and its manufacture.

High density polyethylenes (HDPE) have outstanding properties for packaging materials, pipe, wire and cabling coating, toys, housewares, furniture, storage tanks and countless other both familiar and esoteric products. World-wide production of HDPE from the Phillips process in 1975 is conservatively estimated at 4 billion pounds. At an estimated average cost of 25 cents per pound, manufacturers paid a total of $1 billion for those 4 billion pounds of resin, which they converted into molded parts with an estimated gross worth of more than $4 billion in the secondary market and $8 billion in the final market. More than 9,000 persons are engaged in the production and marketing of HDPE resin from the Phillips process throughout the world. Since commercial production began in 1957, the total output from this process exceeds 16 billion pounds.

The widespread use of HDPE to make containers for detergents, liquid soaps, shampoo, pharmaceuticals, bleach and other such items has helped to eliminate broken glass as a common cause of household accidents. The fear and concern once so widely associated with broken glass containers in the bathroom, in the shower, kitchen and laundry room, are now almost forgotten.

High density polyethylene performs many life-support and life-saving roles as a mesh in surgical procedures, as tubing for hospital use, and in numerous other medical applications, including containers used in hospital care. In its countless applications, this unique plastic has helped to make living safer, easier, more pleasant and less expensive than would be the case without it. In addition, it has made numerous contributions to the military needs of the nation. For example, it provides covering packaging for ammunition, food, blood and other medical supplies in the fields under combat conditions. It has also helped to make communications equipment more reliable with coatings for wire and cable.

High density polyethylene is produced by a relatively simple process that requires less energy to manufacture than most of the other materials it replaces. Since it contains no chlorine or other contaminating substances, HDPE can be incinerated without causing air pollution. Because of a high BTU content, it helps to burn other refuse, which will become increasingly important with the expansion of refuse incineration to generate electric power.

This product of chemical research can be blow molded, injection molded, extrusion molded or thermoformed into one-piece containers, complex shapes, pipe or conduit, sheets or film, all of which translates into useful, safe and durable products for health care, housewares, food processing, manufacturing, farming, communications, education, pollution control, sewage treatment, transportation, recreation, athletics, children's playthings, law enforement, and exploration of the land, the sea and outer space.

Dr. Hogan

Samuel E. Horne, Jr.

"for solving the puzzle of how to polymerize isoprene commercially to "synthetic natural rubber" which had been attempted since 1882 by a galaxy of able chemists." (Awarded 1974) The B. F. Goodrich Company

Dr. Horne

Dr Horne was honored for the duplication of natural rubber; cis-1, 4-polyisoprene. The synthetic material is a replacement for natural rubber.

Five plants have been built around the world by B. F. Goodrich and its licensees, for the production of cis-1, 4-polyisoprene—two in the United States, one in France, and two in Japan. A complete new industry has developed around these plants. In 1976, there were 253 thousand metric tons of synthetic cis-1, 4-polyisoprene consumed in the free world—about 85% of it being produced in these plants. Also directly related, is the development work required for the production of isoprene monomer, the building block of the synthetic natural rubber.

The synthetic natural rubber is a direct replacement for natural rubber in all respects. The impact of this is evident in two important facets: (1) independence of the free world on far Eastern sources of natural rubber in event of crises; and (2) a control of the price of natural rubber—both crucial contributions to national security and the economy.

This AIC honoree's contributions, like those of his fellow honorees, have created a vast number of new jobs, both in the rubber industry and in related industries; it is difficult to estimate their number. ■

Everett C. Hughes

"for pioneering discoveries in petroleum chemistry and petrochemicals resulting in 132 patents and for being the kind of research director who is beloved by both scientists and stockholders." (Awarded 1971) Standard Oil Company of Ohio

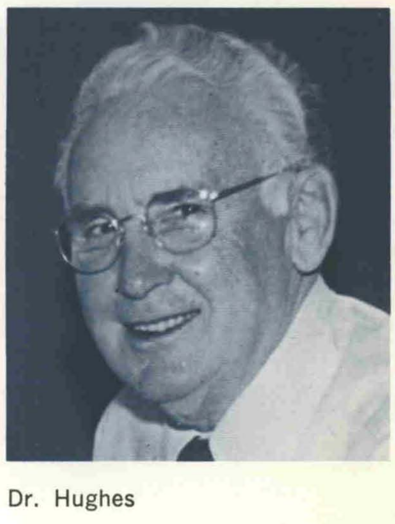
One of AIC Chemical Pioneer Everett C. Hughes' innovations was Boron gasoline. It fulfilled a necessary function during the rapid changes in automotive engines of the '50's and '60's. The rapid combustion engine developments required fuel innovations to sustain them and these fuels brought the gasoline engine to the peak of efficiency. Boron gasoline saved at least 10% of the fuel used for a period of fifteen years, a truly enormous conservation of energy, and this grade of gasoline continues to be marketed.

Dr. Hughes and associates made discoveries in the petrochemical field of "ammoxidation" catalysts that led to low cost acrylonitrile and methacrylonitrile. The price of these important chemicals was halved in a short span of time so that these important chemical building blocks were transformed into acrylic fibres, nylon, and resins on a world-wide basis. Production rose dramatically to over five billion pounds per year in response to the lower costs.

It was a key acrylonitrile catalyst that sparked the world-wide revolution in clothing, carpeting, and the engineering of high strength plastics. The luxurious qualities of the low-cost acrylo-fibres brought the pleasures of fine wool-like clothing within the reach of low-income people all over the world. Furthermore, great areas of farmlands were salvaged so that they could be turned to the production of food instead of fibre.

The value of these discoveries is indicated by their large contribution to the royalty income of the company that employed Dr. Hughes and his associates. This has totaled some $224,000,000 since 1960. The year 1974 was the best so far with $41,000,000. Much of this income came from abroad, thus helping with our country's balance of payments.

New products with much promise for the future have come on the market based on the discoveries that Dr. Hughes championed. One of these is an oxidation catalyst and process for acrolein. This is being used to produce acrylates and acrylic acid. The easily disposable new packaging-resin from the acrylonitrile, called Barex, was another important discovery. It has the lowest gas transmission of any polymer, thus preventing loss of CO_2 or degradative exposure to oxygen for packaging materials. This has been in production for a short time now but will ultimately reach the billion pound per year mark. It has the economic, protective, and environmental properties that will enable it to outcompete the common film-formers for many uses such as preserving foods at top quality.



Dr. Hughes

Herman F. Mark

"pioneer in the investigation of natural and synthetic polymers by a wide variety of methods; inspiring and beloved teacher, he has been largely responsible for bringing polymer chemistry to early maturity." (Awarded 1972) Polytechnic Institute of New York

Dr. Mark

AIC Chemical Pioneer Professor Mark has been a true meteor on the horizon of polymer chemistry for about a half-century. Most, if not all, polymer chemists of modern times owe him a lasting debt of genuine appreciation. They have had to have been touched by his lucidness as the foremost communicator of polymer science in modern times or felt enthusiasm and respect for that branch of chemistry as a result of listening to his lectures. Of course, the Polymer Research Institute at Brooklyn Polytechnic has been the nucleus from which his most lasting contributions have emanated through his associates.

Since the early 1950's the synthesis, characterization and application of graft copolymers was carried on by a group with Turner Alfrey, R. B. Mesrobian and D. Tanner as leaders. The concept of grafting, its various implementations and the behavior of the products obtained have meanwhile led to a large branch of polymer science and through the follow-up by progressive groups of investigators to practical results such as the ABS resins, the modified nylon, Chinon, Cordelon and Utilon fibers.

Another novelty originated at that time under Herbert Morawetz was the concept and realization of polymerization in the solid state. It, too, has proven to be a powerful incentive for additional efforts and has led to interesting approaches for the control of molecular weight and molecular size distribution. At the same time, pioneering work by C. G. Overberger permitted a first step to the synthesis of biologically active synthetics. In addition, the carefully controlled stepwise preparation of oligo- and polypeptides by M. Goodman contributed successfully to the problem of random chain-helix transition. ■

Carl S. Marvel

"for his pioneering research in organic chemistry and high polymers; for his outstanding contributions to education, chemists, and the chemical profession; for his more than 400 publications and patents; and for creative inventions in the development of synthetics, rubbers, and heat-resistant polymers." (Awarded 1967) Wright Patterson Air Force Base

Professor Marvel's long and distinguished career in high-polymer research began long before polymer research became the major thrust of a multibillion-dollar-a-year industrial reality. His expertise was especially useful when the rubber crisis developed early in World War II, and the U. S. synthetic-rubber program was organized. This program was a cooperative affair between industry and universities.

All of the participants pooled their abilities and worked for a common goal without jealousy or attempts to grab personal glory. The need for usable synthetic rubber was satisfied in a remarkably short time. The Government built the plants for production, paid for all the research and manufactured the rubber, and at the end of the program sold the plants back to industry. For a change, the U.S. taxpayer did not lose money.

Also, Professor Marvel's contributions to teaching have been most impressive. He has directed the research work of 305 Ph.D. candidates and research associates from 31 different countries. These chemists have been or are leading professors of chemistry or industrial researchers in their respective countries—a lasting memorial to his dedication in making these people realize that research in chemistry can be a most interesting occupation which can give them a feeling of satisfaction in their jobs and, in turn, stimulate their productivity.

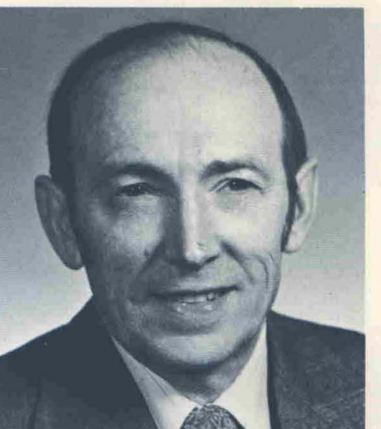
Since 1955, Dr. Marvel has become interested in heat stable polymers. The Materials Laboratory of Wright-Patterson Air Force Base persuaded him to study this problem when it was decided there was a critical need for more stable films, fibers and molding resins than were commercially available. They financed his research efforts.

In 1961 Herward Vogel, in Marvel's laboratory, made a polybenzimidazole from diphenyl isophthalate and diaminobenzidine. It has proved to be one of the more tractable polymers which can be fabricated into a fiber and spun to a cloth which is heat resistant, fire resistant and hydrolytically stable. It will char when heated with a free flame but does not continue to burn when the flame is removed. The char maintains a fair amount of the original fiber's strength. No toxic gases are given off on pyrolysis and very little smoke is produced.

Since the discovery by Professor Marvel and his associates that aromatic heterocyclic polymers were heat and fire resistant, this field has become a fruitful one in this country, Japan, Russia and France. Many new polymers have been prepared. It is only a matter of time before some will be marketed.

Dr. Marvel

Edwin T. Mertz



Dr. Mertz

for pioneering research which proved that among the various strains of Zea mays some contain proteins of exceptional nutritive value. This derives from a larger content of the essential amino acids lysine and tryptophan. His revolutionary and unexpected discovery stimulated related findings in other cereal grains. All of these are of greatly enhanced value for the nutrition of both humans and animals." (Awarded 1976) Purdue University

In 1963, a Purdue team consisting of Dr. O. E. Nelson, Dr. L. S. Bates and AIC Chemical Pioneer Dr. Mertz, found that the corn mutant, opaque-2, had nearly twice as much lysine as ordinary maize. It also contained twice the amount of tryptophan, another amino acid that is too low in corn. This discovery made scientists realize that cereal grain proteins could be improved in quality by genetic manipulation. Since, then, high lysine mutants of barley and sorghum have also been found.

Nutrition scientists in Central and South America and in India decided to test opaque-2 (high lysine) corn in the diets of children suffering from a severe protein deficiency disease, kwashiorkor, occurring in young children eating a diet made up mainly of cereal grains that do not supply enough good quality protein. The levels of protein in the blood of these children fall to abnormally low values. When the dangerously ill children were fed a diet in which opaque-2 corn supplied all of the protein, they recovered completely from this often fatal disease.

The different cereals of economic importance, i.e., rice, wheat, maize, sorghum, barley, oats, and millets, all have one characteristic in common—they are low in the essential amino acid lysine. Amino acids are the building stones of proteins and nine of these, including lysine, are of special importance because humans cannot synthesize them from other dietary ingredients.

It may be concluded from the pioneering work of Professor Mertz and his co-workers that the use of a high-quality protein cereal such as opaque-2 ► (high lysine) maize in the diets of both children and adults would provide protein otherwise available only from a good mixture of ordinary cereals and legumes, or from meat, milk and eggs. High lysine corn, therefore, would help to stretch our already limited supplies and permit us to adequately nourish the extra billions of humans expected by the year 2000.

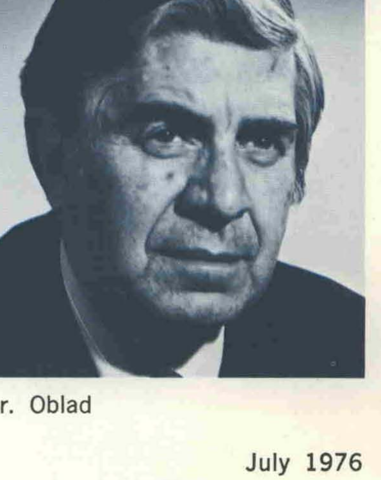
Alex G. Oblad

"a pioneer in the investigation of catalytic cracking, reforming and many other petrochemical processes, brilliant research leader, devoted scientists, and man of sterling character and humility." (Awarded 1972)

Dr. Oblad, working with outstanding research professionals as associates, was able to make contributions to a number of present day large-scale processes—in production of high octane gasoline, chemicals from petroleum, and synthetic ammonia—such as catalytic cracking, catalytic reforming, production of butadiene and isoprene, polyurethane foams, and production of ethylene and propylene.

Development and expansion of catalytic cracking and catalytic reforming has continued over the years until these are most important of all processes involving catalysts. Dr. Oblad's work contributed greatly to an understanding of how these catalysts work and, in part, led the way to improvements in processes and catalysts which now make available large quantities of high performance fuels for internal combustion engines—fuels made efficiently from petroleum so that our resources are conserved—important now with scarce energy reserves. As time unfolds, further conservation will ensue as these processes are used on an even larger fraction of our petroleum resources and are adapted for use in developing energy resources such as coal, oil shale, and tar sands.

Synthetic ammonia was difficult and expensive to make on a large scale even though the process at the time was approaching a half-century of use. Growth of human population was such that improved ways for producing fertilizers was a must if starvation was to be avoided. Dr. Oblad succeeded in improving the process for production of synthetic ammonia so that it could be made on a scale 10 times as large, and much cheaper. The choice of petroleum feedstocks for making hydrogen was expanded and this made it possible for ammonia to be produced world-wide, not just near available natural gas. As a result, synthetic ammonia as a fertilizer is available to farmers everywhere in the world at a price they can afford, and so ample food can be produced for everyone.



Dr. Oblad

Linus C. Pauling

"for pioneering research and thinking on the nature of the chemical bond which has been of great help and inspiration to generations of chemists." (Awarded 1975)

Dr. Pauling at ACS Centennial.

Professor Linus Pauling, one of several Nobel Prize winners whose profiles appear in this Bicentennial issue of *The Chemist,* stands tall in reputation and stature among the world's great thinkers. He has received a Nobel Prize twice in his lifetime.

The "extraordinary scope and power of Professor Pauling's imagination" have led to basic contributions in such diverse fields as structural chemistry and the nature of chemical bonding, molecular biology, immunology, the nature of genetic diseases, the role of vitamin C in health, and world peace!

"Dr. Pauling's stature as a scientist has always been outside the realm of controversy, whatever differences other scientists may have had with one or another of his views. Awarded the Nobel Prize for Chemistry in 1954, he is the author or co-author of more than 400 papers. His range has been among the most impressive aspects of his genius. He helped to clarify the nature of the chemical bond, including the phenomenon of resonance in chemistry; has made major contributions to the understanding and structure of proteins, the structure of antibodies and the nature of serological reactions; has elucidated the structure and properties of hemoglobin; has helped to explain the hereditary hemolytic anemias, and has developed a chemico-biologic concept of psychiatry known as orthomolecular psychiatry."

Today, AIC Chemical Pioneer Linus Pauling is a champion of the belief that, now more than ever, "we should discuss the relation of chemical work to the advancement of mankind, not only in the past century, but also the possibilities for the coming century." ■

Benjamin Phillips

"for pioneering research in the chemistry of chemical intermediates, monomers, and high polymers; for outstanding leadership in industrial research; and for creative inventions described in some 120 patents and publications, many of which are the basis for the commercial manufacture of peracetic acid, plasticizers, stabilizers, epoxy resins, vinyl epoxy monomers, condensation resins, peroxides and lactone derivatives." (Awarded 1967) Union Carbide Corporation

Among the products that have emerged in one way or another from Dr. Phillips' contributions are epoxy resin applications that include castings, reinforced plastics, adhesives, and surface coatings. Special properties that can be achieved with these materials include excellent electrical properties, high-temperature stability and resistance to weathering. For example, one of these resins is used as a replacement for porcelain in outdoor high-voltage service, another is used in the form of filament-wound reinforced plastics for Minuteman, Polaris, Poseidon, and Sprint missiles.

In the early 1950's Dr. Phillips and his co-workers with Union Carbide conducted research which led to a safe efficient process for manufacturing peracetic acid by the autoxidation of acetaldehyde. In 1956, Union Carbide constructed a peracetic acid production facility, utilizing the new process. With an initial capacity of ten milion pounds of peracetic acid per year it is believed to have been the first commercial production unit for the manufacture of an organic peroxide by autoxidation. A few years later, the capacity was expanded to 15 million pounds per year. By 1967, a much larger production unit, with a capacity of 100 million pounds per year, was brought into operation.

Epoxidized natural oils and their derivatives are widely used as plasticizers and stabilizers for vinyl resins. Today, major quantities of these products are made with peracetic acid (Union Carbide process) since it provides an economical route to products having high oxygen content.

One of the most useful products is epsilon-caprolactone, which is manufactured by oxidation of cyclohexanone with peracetic acid. This C_6 lactone is a building block in many commercial polyols for polyurethanes, including, for example, frothed foam systems for leather-like fabric coatings.

Dr. Phillips has derived great satisfaction in recent years from watching the succession of new peracetic-acid-derived products developed and marketed following his own earlier work in the field. One of his current interests is the utilization of renewable resources, particularly low-cost carbohydrates, as starting material for the manufacture of industrial chemicals. He thinks that peracetic acid can play an important part in a "renewable resource chemistry" because its precursor, acetaldehyde, is readily derived from such sources.

Dr. Phillips

Charles J. Plank

"for joint inventorship of the first commercial zeolite cracking catalyst, exhibiting unprecedented activity and selectivity for the manufacture of motor fuel." (Awarded 1974) Mobil Oil Corporation

Dr. Plank

Catalytic cracking of petroleum to produce gasoline is still by far the largest catalytic process. Well over 4,000,000 barrels of oil are fed into cracking units in the United States every day. Because of the size of the catalytic cracking industry the qualitative benefits introduced by the invention of commercially useful zeolite cracking catalysts, brought about tremendous quantitative benefits. In addition to the basic patent on the first commercial zeolite cracking catalyst, Dr. Plank and his co-inventor, E. J. Rosinski, have received 28 more patents dealing with zeolite cracking catalysts—two of them within the past two years.

Early catalysts gave increases of 18 to 20% in gasoline, at a given conversion, while the yield of dry gas and coke decreased by 30 to 40%. That is, at a conversion where they would have obtained 40% gasoline on the old silica-alumina catalyst the new catalysts gave the chemists about 48% gasoline. In addition, the lower coke yield allowed them to increase conversion and refinery unit capacity, thus producing even more gasoline. Newer refinements of the catalysts have yielded still further selectivity improvements.

Between the time Mobil Oil Corporation announced the catalyst in 1962 and the end of 1973, over 90% of the cracking industry adopted the use of zeolite catalysts. In so doing, the industry, and ultimately the U.S. public, had achieved a savings estimated at more than $3 billion in reduced petroleum and refining costs compared to using the old silica-alumina catalysts. At that time the savings were running at the rate of $450 million per year. Since the Arab oil embargo, the price of petroleum crude has quadrupled. Thus, the present rate of savings to the country is well over one-half billion dollars, possibly as high as one billion dollars annually.

To look at the savings from another and more currently crucial point of view, what does the switch to zeolite cracking catalysts mean to the United States in terms of its dependence on foreign oil? If we were still using the old catalyst, we would have to import another 200 million barrels of crude each year. At the present price of over $11 per barrel this would mean contributing a deficit of more than $2 billion annually to our foreign trade balance. And in the event of another oil embargo we would be in a much worse position than at the time of the first. In view of the great economic gains to be obtained with even modest gains in selectivity, there is still a definite incentive to improve these catalysts still further.

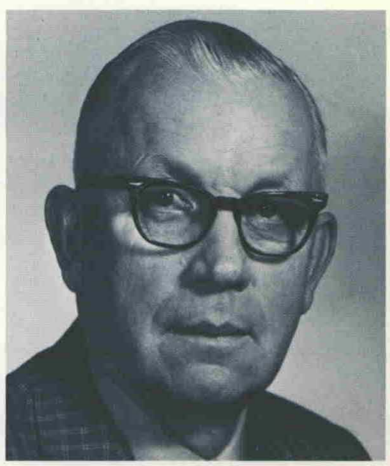
Roy J. Plunkett

"for the discovery of tetrafluoroethylene, better known as "Teflon." His product has been called the "noble metal" of the plastics family." (Awarded 1969) E. I. du Pont de Nemours, Inc.

Dr. Plunkett's discovery of the "Teflons" has led to production of several hundred million pounds of the tough, chemically-resistant fluoroplastics over the last three decades. U. S. production of granular fluorocarbon resins, for example, totalled nearly 20 million pounds in the 1974-75 period, and sales of the resins had reached an annual level of about $25 million. The industry expects sales to continue at least at that level in the future. Worldwide, the production of these basic fluorocarbon resins is about double the U. S. figure, with European and Japanese markets growing at a slightly faster rate than the U. S.

While it is difficult to separate out the proportion of overall plastic industry workers assigned to fluorocarbon resins, it is safe to say that several hundred production workers and probably as many sales personnel owe their jobs in large part to Plunkett's early work. Thousands of others, of course, are employed in plants which mold items from the versatile resins or assemble the molded products into finished goods.

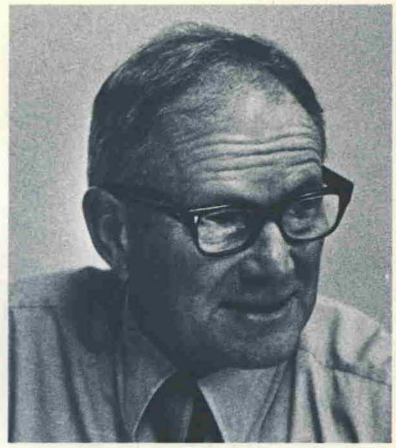
While never expected to attain the volume of commodity plastics such as polyethylene or styrene, the fluorocarbon resins are becoming increasingly important as industry demands materials with higher temperature and better chemical resistance. Their inherent slipperiness and the fact that virtually nothing sticks to them has led to innumerable applications, ranging from cookware coatings to valve linings and bearing pads, where their built-in lubricity eliminates the need for lubricants. Their high dielectric strength and excellent insulating properties have been utilized in many electronic applications. Chemical inertness of the compounds has led to the medical industry's use of them in such items as valves for artificial hearts and ball and socket devices to replace diseased or damaged hip joints. ■



Dr. Plunkett

Charles C. Price

"for his pioneering work in polymer chemistry; for his outstanding contributions to teaching and to academic research; for his leadership in the American Chemical Society in relation to National Scientific policy; and specifically for his key invetion in the development of polyurethane technology" (Awarded 1966)
University of Notre Dame



Dr. Price

Polypropylene glycol polyurethan rubber, first prepared while Dr. Price was at the University of Notre Dame in the summer of 1949, has become a major worldwide article of commerce. It has largely replaced foam rubber for such applications as mattresses, furniture, automobile seat cushions, safety cushions, etc.

In addition to advantages in cost, the process provides material easily molded to desired shapes and readily varied in density and stiffness for a wide variety of applications.

This product is manufactured in almost every developed nation and has been, in major part, responsible for the large growth of the polyurethan industry. The large scale use of the invented product has led to industrial synthesis of diisocyanates at an economic level which has helped make possible many other applications of polyurethan chemistry.

Dr. Price is now Benjamin Franklin Professor of Chemistry at the University of Pennsylvania. He continues research on polyethers. His most recent book on "The Origin of Life" reflects another interest, as does his Chairmanship of the Council for a Livable World, a political action group centered in Washington which is devoted to the purpose of minimizing, and hopefully eventually eliminating, the risk of nuclear war. ■

Eugene G. Rochow

"for his leadership in industrial and academic chemistry; for his many contributions to the development of inorganic chemistry as a modern science, and specially for his pioneering work on the synthesis and application of silicones as a new modern industry." (Awarded 1966)

AIC Chemical Pioneer E. G. Rochow is well recognized for his outstanding original contribution to Organosilicon Chemistry and Silicones. His area of expertise is especially significant in the light of the historical panorama which preceded his research.

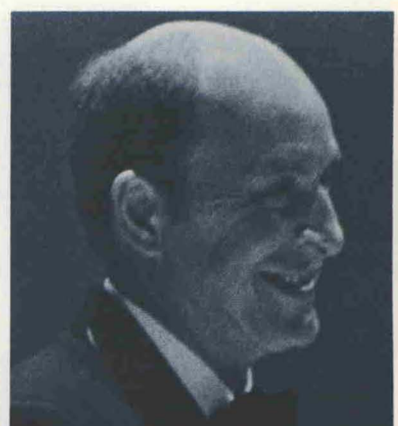
For example, chemistry, which has its roots in the ancient ceramic arts, dates back at least ten thousand years. Systematic study of inorganic silicate chemistry was well advanced even 8,000 years ago, when vitreous enamels in many beautiful colors were applied to gold masks and caskets of Egyptian kings, and has continued without interruption into today's greatly-expanded field of ceramic chemistry.

However, no one realized that silicon also forms organic derivatives until 112 years ago, and then no industrial support for their study surfaced until the late 1930's. Since then some 20,000 new organo-silicon compounds have been prepared, many of which touch on important areas of medicinal, analytical, and biological chemistry. In addition, an entire new industry has been created, devoted to the production of six million pounds per year of silicone polymers and related commercial products. A worldwide network of research centers has been established. Over 600 research workers gathered at the Fourth International Symposium on Organosilicon Chemistry in Moscow in 1975—striking evidence of the present stature of this specialized branch of chemistry.

All of this activity stems from the realization that organosiloxanes (silicones) can survive extremes of temperature and resist destructive oxidation better than purely organic polymers can. Moreover, organosilicon compounds convey some properties (such as adhesiveness and extreme water repellency) which natural products and organic substances cannot match, leading to a large variety of special products to help all phases of industry.

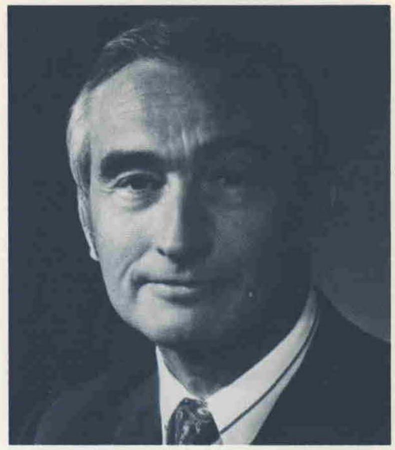
Special contributions have been made to the safety and comfort of aircraft, where silicone rubber seals the windows and doors, insulates the wiring, and seals the heating ducts. The most spectacular applications have been to space travel: silicone sealants and lubricants insured the operation of the Apollo vehicles, and silicone rubber boots, gloves, and space-suit parts allowed the astronauts to explore the moon under the extremes of the lunar day and night. The most vital applications have been to prosthetic surgery, where spare parts for the human body, fabricated from silicone materials, have allowed continued functioning of vital organs and external members.

Before 1940 all organosilicon compounds had to be made by Grignard reaction or with the help of related organometallic reagents. Today the essential intermediates are made by the direct synthesis of organochlorsilanes from elementary silicon and hydrocarbon chlorides. No ether is needed, nor any magnesium or sodium.



Dr. Rochow

Lewis Sarett



Dr. Sarett

"brilliant innovator in the complex, difficult field of steroidal medicinal chemistry, the man who first synthesized cortisone and helped to give the world Decadron, inventor or co-inventor of more than 140 patents based on creative research whose purpose is to give people longer, healthier lives." (Awarded 1972) Merck Sharp & Dohme

In 1948, a physician at the Mayo Clinic administered a new drug, available then only in miniscule quantities for research purposes—to a 29-year-old woman who was crippled by rheumatoid arthritis. Nothing happened. The next day she received a second injection. Again nothing. Her swollen and painful joints, progressively stiffened through her illness, still kept her immobilized. But on awakening the third day, she was able to turn over in bed with ease. Most of her pain had disappeared. And less than a week after the first injection, the woman went on a three-hour shopping tour.

The new drug was cortisone, the first of the corticosteroid hormones. As the chemist who, in 1944, first synthesized cortisone and who played a part in producing the drug used in that Mayo Clinic trial, Dr. Sarett has been proud of his role in that medical scenario. It opened up a new world of relief from suffering for hundreds of thousands of arthritics.

Since the discovery of the therapeutic value of cortisone, the utility of corticosteroids has increased to where they are used to treat some 80 disorders—inflammatory diseases such as rheumatoid arthritis and rheumatic fever; bronchial asthma and other allergic diseases; skin diseases such as atopic dermatitis; digestive disorders such as ulcerative colitis and metabolic problems like acute gouty arthritis.

Other contributions to corticosteroid research by the laboratories with which Dr. Sarett has been associated include the first synthesis of hydrocortisone, the naturally-occurring hormone which largely replaced cortisone in therapy, and dexamethasone, a compound some 35 times more potent than cortisone and which has fewer side effects. While research on corticosteroids as anti-inflammatory agents lately has not been of major interest, the scientific achievements of some 30 years ago continue to serve as a foundation upon which drugs evolving today are based. Dr. Sarett has added most significantly to the scientific legacy of new challenges and opportunities for generations of chemists to come. ■

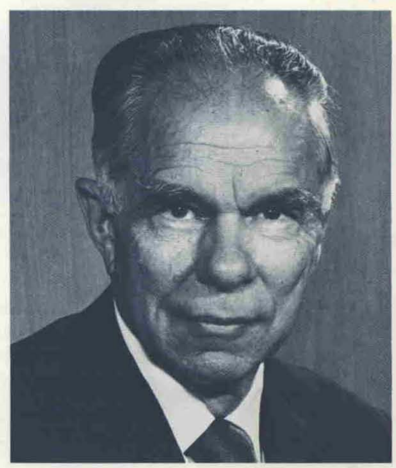
Glenn T. Seaborg

"for pioneering research in the fields of nuclear energy and transuranium elements, including that leading to the first self-sustaining nuclear reaction; for the discovery or co-discovery of americium, curium, einsteinium, fermium, mendelevium, plutonium, berkelium, californium, plutonium-239 and uranium-233; for major contributions to the practical and beneficial use of nuclear phenomena; and for inspiring and creative leadership and organizational skill in scientific, educational, and government affairs." (Awarded 1968) University of California

Nobelist Glenn T. Seaborg's AIC Chemical Pioneer citation is lengthy because it recognizes an array of related pioneering discoveries. The synthesis and identification of transuranium elements has now reached a total of 14, including all the elements through that with the atomic number 106. Distributed among these 14 elements are more than 150 isotopes. It seems certain that additional elements will be added to the list. Of special interest is the possibility that the so-called "superheavy" elements—the elements with atomic numbers in the range of 110 to 120—will be added to the Periodic Table.

Plutonium-239 and uranium-233, the man-made fissionable isotopes, have extensive potential for use as nuclear fuels. In addition, other transuranium isotopes are providing appreciable benefits to society. Plutonium-238 serves as an energy source for cardiac pacemakers and such diverse uses as the source of electric power for communication instrumentation left on the moon by our astronauts. Americium-241 serves in the medical field as a diagnostic tool for thyroid disorders. Californium-252 is providing a compact, portable, intense neutron source for use in exploration for oil and minerals, other applications of neutron activation analysis for pollutants, and perhaps as a means of cancer therapy.

Included in the research honored by this Award is the synthesis and identification of isotopes which have found an almost universal application in our nation's hospitals and clinics. They are used more than 10 million times a year, accounting for a substantial proportion of all the applications of radioisotopes to the diagnosis and treatment of disease, and have led to alleviation of human suffering throughout the world.



Dr. Seaborg

Joseph H. Simons

"for pioneering the flurocarbons, a family of extremely stable, inert and useful compounds, now known widely as plastics, coatings, lubricants and refrigerants." (Awarded 1971)

Dr. Simons

Some 50 years ago, fluorine chemistry was not a popular field for research. Somewhat less than a handful of people in the world were interested in it, the competition was minimal and great competence unneeded.

A scared, small, and puny graduate student, Joseph H. Simons, in the wild country far beyond the Rocky Mountains at Berkeley, Calif., in the year 1922 was seeking a subject for research. Fluorine chemistry could always be depended upon for publications, and Dr. Simons chose to search for compounds from which the highly reactive CF_3 radical could be captured. Out of years of working to achieve this objective came many useful by-products—many kinds of fluorocarbon derivatives containing elements such as nitrogen, oxygen, sulfurs and even hydrogen.

Interestingly, Dr. Simons projected in 1971, when he became an AIC Chemical Pioneer, that the major commercial developments of fluorine chemistry would come in the future. "Because of their stability fluorocarbons and their derivatives should outnumber all isolatable organic compounds. Surely many of these will have important properties for utilization purposes from pharmaceuticals to materials of construction, plastics, elastomers, resins, surface coatings, liquids and gases for many purposes. Fluorine is amply plentiful. It is three times as abundant as carbon. New materials should make Teflon and the Freons obsolete." ■

Foster D. Snell

"for his many contributions to surface chemistry and specifically for his role in the invention of aerosol propelled shave foam." (Awarded 1970)

This AIC Chemical Pioneer's contribution to a great convenience in every day life has been singled out for his profile. There was a time, some older readers will recall, that lather was generated from soap in a mug with a shaving brush. Then followed shaving cream in a tube, then "brushless shave", and finally the competition of the electric razor.

A product that was not particularly successful consisted of soda water siphon which is filled with tap water and charged with carbon dioxide by liberating the contents of a metallic cartridge. One day by appointment, George Spitzer disclosed to Dr. Foster Dee Snell a highly confidential project. He wanted a soap solution put in such a bottle and charged with a gas to deliver a lather for shaving. Of course, carbon dioxide could not be used. A single experiment confirmed that under pressure it acidified the soap, destroyed it, would not give lather. At that time nitrous oxide under pressure was being used to produce whipped cream. It did not work with a soap solution because the lather collapsed when rubbed. Analysis of the use of nitrous oxide showed that it acted by dissolving in the fat of the cream.

The solution proved to be a finely divided emulsion of a liquified gas which was insoluble but emulsifiable in soap solution. Freons seemed a logical solution but experiments showed that many of them caused a burning sensation when the lather was rubbed on the skin. Freons were used then only as refrigerants. Some of them selected by test became lather propellants. Then came problems of can design, corrosion-resistant linings, pressure controls by mixing appropriate freons, etc. The team that solved the many problems included, in addition to the patentees, (George Spitzer, Irving Reich and Norman Fine) Lloyd I. Osipow, Dorothea Marra, along with Kurt Konigsbacher.

The sales of the pressurized lather containers throughout the world, not necessarily in conformity to the original patent, but under the basic concept, is a figure which is not obtainable. Manufacture in the U. S. alone in recent years has been over 150 million units and has increased year by year. The shelves of any drug store show the commercial success.

The development of a new method of making pressurized lathers led to pressurized containers of cold-wave lotions and other products. Basically, this was a product based on an invention involving a simple chemical reaction, which largely took over a market because of its convenience.

Dr. Snell

William J. Sparks

"for the invention of butyl rubber and for his great interest in the professional advancement of chemists." (Awarded 1970)

Dr. Sparks

The prime inventor of butyl rubber, Dr. Sparks is an AIC Chemical Pioneer extraordinary; when he received the Award he already had over 135 United States patents issued in his name! As of 1976, there are commercial plants manufacturing butyl rubber in the United States, Canada, France, Great Britain and Japan. The plants are doing very well. The exact production figures are not known. They are in the hundreds of millions of pounds a year category.

On the occasion of receiving the Chemical Pioneer Award, Dr. Sparks offered some profound comments. They relate so intensely to the theme of contributions of chemists to society that they are most appropriate in this Bicentennial Issue: "Your award on this occasion indicates that I was somewhat successful at inventing. However, during that time, two conclusions were evident, according to Dr. Sparks, "(1) my administrative activities earned more money and (2) my public service efforts were more rewarding. On many occasions I have pointed out that the failure of industry and the patent community to properly reward invention would ultimately be self-defeating." ■

Jerome S. Spevack

"for pioneering research in separating deuterium from ordinary hydrogen, a necessary step in its utilization for the production of energy by fusion reactions." (Awarded 1976) Deuterium Corporation

Recipient of the 1976 AIC Chemical Pioneer Award for his discovery and pioneering research, Dr. Spevack has given society a commercially feasible process for the production of deuterium and heavy water (deuterium oxide) from ordinary water. Deuterium is the rare heavy isotope form of the element of hydrogen. It exists in all natural water in the ratio of one atom to 7,000 atoms of ordinary hydrogen.

Spevack's invention of the dual temperature isotope exchange method for concentrating isotopes and his innovative development of the hydrogen sulfide-water system, called the "GS" process, opened new horizons in man's search for low cost, abundant, clean power. The "GS" process, which can make deuterium fuel inexpensively and in unlimited quantity, has forged a necessary link of generation of electricity by thermonuclear fusion—the power of the sun. Progress in world research to control deuterium fusion is expected to demonstrate the reality of this source of energy within ten years. Calculations show that the energy available from fusion of the deuterium in a single gallon of ordinary water, only one-eighth of a gram, is equal to that from the combustion of 300 gallons of gasoline. Using the "GS" process, it costs only about two cents to extract the quantity of deuterium contained in one gallon of water.

When our nation's national defense program required development of the thermonuclear "hydrogen" bomb in the 1950's, the Atomic Energy Commission invested almost $200 million for two 400-ton per year heavy water production plants based on Spevack's "GS" process, at Savannah River, S.C., and Dana, Ind. These facilities produced over 10 million pounds of heavy water at a cost of $13 per pound compared with the Government's World War II costs of $200 per pound by the water distillation process. Spevack's "GS" process saved American taxpayers more than $2 billion. Today, 25 years later, the Savannah River plant still is producing the heavy water required for our national security.

The availability of low cost heavy water by Spevack's "GS" process also has helped Canada to achieve preeminence among the nuclear electric power producing nations of the world.

Canada now has in operation and under construction several large "GS" process heavy water plants, representing a capacity of over 3,000 tons per year and a capital investment of over one billion dollars. Canada's success with heavy water moderated nuclear reactors coupled with its low cost heavy water production by the "GS" process is enabling it to conserve its fossil fuels, to extend the values of its uranium mineral resources and to sell its nuclear power technology to worldwide markets.

The growing international acceptance of the heavy water moderated nuclear power reactor and the emergence of controlled thermonuclear fusion power may soon challenge physical and financial capabilities to construct needed heavy water production facilities. Spevack and Deuterium Corporation, the company he organized over 15 years ago to commercialize heavy water production by the "GS" process, have developed further improvements and economies for the "GS" process.

Dr. Spevack

Max Tishler

"for pioneering research in combatting the scourge of human hunger through practical synthesis of nutritional supplements including vitamins and amino acids, as well as contributions to the stores of economical animal protein through animal disease control; for contributions to the health of mankind by the production of therapeutic measures including sulfa drugs, antibiotics and steroids; for outstanding enrichment of scientific knowledge by some 200 patents and publications; for enlightened management and inspiring leadership of a great research enterprise; and for vigorously championing the professional integrity of the research chemist." (Awarded 1968) Merck & Co., Inc.

Dr. Tishler

Many of the developments with which Dr. Tishler has been associated have had a major impact on health. He has contributed directly as a working chemist or as a Director of Research and Development to a wide range of important pharmaceutical products.

Vitamin B_2, vitamin B_6, ascorbic and niacin and vitamin B_{12} are very widely used. Vitamin deficiencies are rarely seen today largely because of the enrichment programs made possible by the availability of vitamins at low costs. The antibiotics—penicillin and streptomycin—have saved millions of lives, and have eliminated the fear associated with many of the infectious diseases.

Dr. Tishler was also associated with the development of the thiazides which were a breakthrough for renal-cardiac diseases. This class of compounds are today basic drugs for the control of edemas and hypertension. The thiazides and the most recent alphamethyldopa are probably the most widely used drugs for the treatment of hypertension. Millions of patients around the world are treated with these drugs with good results in effecting hypertension control and in prolonging life.

In the field of veterinary medicine, AIC Chemical Pioneer Max Tishler helped to develop the poultry industry. Sulfaquinoxaline, mixed into feed, was the first agent used widely as a prophylactic against poultry coccidiosis. This was followed by thiabendazole, an effective drug for the control of helminths in sheep and cattle.

Following 32 years in the research laboratories of Merck & Co., Inc. (over 200 U.S. patents and scientific publications), Dr. Tishler, in 1970 retired and accepted a post as professor of chemistry at Wesleyan University in Connecticut. Two years later, he was distinguished as University Professor of the Sciences. Dr. Tishler also served for two years as Chairman of the Department of Chemistry. He also served in 1971 and 1972, first as President-elect and then as President of the American Chemical Society. ■

Harold C. Urey

"for his work on the discovery of heavy water and his subsequent contributions to the isolation of pure Uranium 235 during World War II. (Awarded 1969) Columbia University

The most important discovery by Dr. Urey, one of the world's most venerable living Nobelists, was deuterium, or heavy hydrogen—discovered by Urey and his assistant George Murphy at Columbia University in 1931, with aid from F. G. Brickwedde. Toward the end of World War II, after the explosion of the atomic bombs in Japan, the hydrogen bomb was invented. One of the constituents of the hydrogen bomb is heavy hydrogen or deuterium. Dr. Urey feels that it is unfortunate that this bomb exists because it is one of the most dangerous articles that we have on the face of the earth at the present time.

More recently, a very interesting point has turned up in regard to the abundance of deuterium in the solar system. The primitive deuterium abundance, according to the physicists, is one part in 50,000 of light hydrogen. This was found to be about the amount of He-3 in the sun's surface. Deuterium plus the hydrogen nucleus gives H-3, tritium, and this decays into He-3. The amount of helium in the sun's surface proves to be about the same as that expected if it was produced by this burnup of deuterium, as assumed by Geiss.

Also Jupiter has about one part in 50,000 of deuterium in its atmosphere, according to the latest experiments. The amount of heavy hydrogen on the surface of the earth is about one part in 6-7,000 and recently, Craig has shown that the hydrogen of the earth's interior has nearly the same proportion as deuterium. In order for such an increased concentration as this to occur, it is necessary that hydrogen and water be mixed and cooled to very low temperatures. This indicates a very cold stage during the origin of the earth, and heating hydrogen and water together would, of course, mix up the deuterium again between the two and such heating cannot be assumed until the hydrogen is lost from the earth. A very interesting datum in connection with the origin of the solar system comes out from this.

During the last 25 years, Dr. Urey has been devoting his attention to the solar system, its origin, the moon and the meteorites. As yet, however, no generally accepted theory of solar, planetary and lunar origin has been devised, but many valuable data have been researched.

Dr. Urey

Christiaan Van Dijk

"for inventing the first successful new process in 80 years for the manufacture of chlorine which enables the industry to generate chlorine without the concomitant production of alkali and without large power requirements." (Awarded 1975) The M. W. Kellogg Company

Dr. Van Dijk

Dr. Van Dijk has pioneered the development of the Kel-Chlor process. This invention is based upon the use of a homogeneous catalyst of the nitrogen oxide type to convert a mixture of hydrochloric acid and oxygen at high temperatures, together with significant amounts of the catalysts, mostly nitrogen dioxide. The gas stream is then contacted at lower temperatures with a large recycle of sulfuric acid, which in absorbing the catalyst also helps to further convert the hydrochloric acid. Also, the water formed in the reaction is absorbed by the acid.

In another part of the system the acid stream is contacted with incoming hydrochloric acid, which strips the catalyst out in the form of gaseous NOCl. Thus, clean sulfuric acid is obtained, only containing the water of reaction. Finally, the hot sulfuric acid is flashed at lower pressure to remove the water of reaction, this without the need for heat input. After some cooling the acid is ready for recycle.

Chlorine is one of the highest volume commercial chemicals. In most uses of chlorine, hydrochloric acid is developed as a byproduct. Earlier such acid was mostly used for the surface waters, thus leading to contaminations of rivers and lakes. To avoid such contaminations in the future it has become mandatory to plan for recovery of hydrochloric acid from such pickling liquors. Therefore, far less HCl will be used in this application. So, a large new use had to be found for HCl. What better solution to the problem than to convert the byproduct back to the starting material, chlorine?

The first commercial plant using the Kel-Chlor process has been built by E. I. du Pont de Nemours, Inc. in Corpus Christi, Tex.—capable of producing 600 tons per day or more of chlorine. The plant has been on stream since 1974.

In the above-mentioned du Pont plant, the high pressure condiitons preferred require extensive use of the expensive metal, tantalum. For smaller plants Pullman Kellogg is now proposing bricklined equipment. In this way, plants with capacities as low as 150 TPD have become attractive. ■

Bartholomeus van't Riet

"for his original concepts regarding the use of surface active dyes in breaking up and preventing the formation of kidney stones." (Awarded 1973) Medical College of Virginia

More than 65% of the population produce urine supersaturated by calcium oxide for at least part of every 24 hours. Nevertheless relatively few people form kidney stones. Dr. van't Riet investigated the problem and became an AIC Chemical Pioneer.

He reasoned that the presence of crystallization inhibitors in the urine might be the reason that more persons do not develop kidney stones. If the principal reason for stone formation is the absence of an adequate quantity of inhibitor in the urine of a patient, then he reasoned that methylene blue may act as a substitute inhibitor. His work indeed showed that treatment with methylene blue dye, (65 mg three times per day), is particularly useful under conditions when other treatments fail. Clinical studies, indeed, revealed improvements in about two of every three such patients after dye treatment, and in none of these patients did the size of existing stones continue to increase. Methylene blue can also serve as an indicator of the presence of an infection, evidenced when a dose of the dye does not produce a blue color in the urine. Methylene blue can also be helpful as a precautionary measure after surgery on the kidneys or the bladder.

There is a 95% chance of stone formation in rats when a foreign body is implanted in the bladder. There is even a 5% chance of stones when just an incision is made and closed. Methylene blue seems to inactivate centers of crystallization which can be generated during surgery.

The approval of such a novel use of a drug by the Food and Drug Administration is required before this new application of the drug can be promoted. Until this approval is granted relatively few physicians will be aware of the benefits of the methylene blue treatment even though the clinical data to date are strikingly positive.

Dr. van't Riet

Hervey H. Voge

"as an internationally recognized expert in heterogeneous catalysis theory. His published work in catalytic cracking is acknowledged as outstanding in its contribution to the scientific understanding of the catalytic cracking of petroleum hydrocarbons." (Awarded 1969) Shell Chemical Company

Dr. Voge

Working with Shell, Dr. Voge pioneered research in heterogeneous catalysis which led to the large-scale production of butadiene during World War II. What are the catalysts? For manufacture of butadiene, the catalysts named Shell 105 Catalyst and Shell 205 Catalyst, are small (3-5 mm diameter) cylinders of porous iron oxide plus other chemicals. They look a bit like certain types of dog food. But when they are packed into a reactor vessel and hot hydrocarbon vapors, along with steam, are passed over them, then desirable dehydrogenation reactions take place. Although the Shell 105 Catalyst was originally developed for the butadiene reaction, it proved to be even more effective for the styrene reaction. Thus both these important "monomers" can be made by the same general method.

After separate preparation and purification butadiene and styrene can be combined and polymerized to form a synthetic rubber called S-B rubber, and this type of rubber has been very widely used since the days of World War II. There are also many other uses for these chemicals. Styrene, in particular, can be polymerized to form many grades of polystyrene plastics which find extremely wide use for appliances, construction, toys, household articles, etc. Another example is an A-B-S polymer, made from acrylonitrile, butadiene, and styrene, which can be formed into excellent pipe for sewers and drains.

Heterogeneous catalysts, which are usually solids over which gases and liquids are passed, have been likened to the "philosophers stone" sought by the alchemists for the conversion of lead to gold. The modern catalysts, without themselves being changed, convert less valuable materials to more valuable products. Dr. Voge has in the course of his work developed a number of other catalysts; some for chemical manufacture. Others, for specialized applications, such as the spontaneous decomposition of hydrazine, are used by NASA and others in small thrusters. Based on the invention of Dr. Voge they control the orientation of virtually all satellites launched by the Free World. ■

Paul B. Weisz

"for discovery and elucidation of selective catalysis responsive to the shape and size of reactant molecules by the use of selected crystalline zeolites as heterogeneous catalysts." (Awarded 1974) Mobil Research & Development Corporation

Along with several other living Chemical Pioneers, Dr. Weisz made important contributions to the petroleum industry. The early findings that crystalline aluminosilicate "zeolites" constitute a promising and basic class of catalytic solids were followed by an ever growing volume of research on catalytic and related properties of zeolites. Out of this research came the ability to vary the chemical nature of the internal sites of such catalysts, and to control molecular shape-selectivity. This latter versatility is an unusual feature for controlling the access and exit of molecules by precisely determined dimensions of ports or channels of the zeolite crystals in which the catalytic activity is contained. The zeolite cracking catalyst developed by Dr. Weisz and coworkers and others now can be found in essentially all cracking units of the petroleum industry in the United States.

New developments continue. For example, ethylbenzene can now be produced without the use of aluminum chloride, but with a clean solid, which is a long-lived catalyst. Xylene isomerization over a zeolite catalyst gives high yields and a long cycle life. Toluene can be efficiently transformed to xylene and benzene by a new disproportionation (Mobil's) process. In the petroleum field, the shape-selective naphtha upgrading process "Selectoforming" has undergone several commercial uses in Europe; another important process for winning larger fractions of low sulfur distillate fuels has emerged.

The significance of Dr. Weisz's research, at a time when U.S. petroleum reserves are waning but U.S. sources of carbohydrates and carbon are almost inexhaustible, cannot be overestimated; it could prove to be the most secure short-term answer, at least, to our self-sufficiency in energy for the next 25-50 years!

Dr. Weisz

David W. Young

"for his pioneering research in a broad area of petrochemistry and applied chemistry; for the numerous inventions described in more than 200 patents; and for his important contributions to the development of industrial petrochemicals, synthetic lubricants, and additives for lubricants used in jet engines and in rocket launching systems." (Awarded 1967) Sinclair Oil Corporation

Dr. Young

In 1936, David W. Young left the University of Kentucky to work in industry with the late L'Roche G. Bousquet at Allied Chemicals Corporation. Dr. Bousquet was a titanium chemist and his contagious enthusiasm inspired Dr. Young to pursue this field and by 1940, his first patent on titanium was filed. It covered a method to make pure *titanium dioxide pigment* in the rutile form, by heating a chloride salt under specific conditions; the process then in use made the pigment in the anatase form from the basic sulfate. Today, over 50% of all the titanium dioxide pigments made and used in industry is in the rutile form, made by the process described in his patent.

Dr. Young played an important role in development of polybutene, leading to the emergence of the highly successful high-impact plastics of the chemical industry.

During the period 1940-1955, while working at Esso Research and Engineering Company, Dr. Young concentrated heavily on the polymerization of olefins, diolefins and copolymers, and their end-use applications. Out of this work came new *catalyst systems* for low temperature polymerization of olefins in liquid phase.

In the early 1950's the petroleum and chemical industries were being informed that jet engines would replace the piston engines for commercial airlines, and that new synthetic lubricants would be required. Mineral oil fractions would not work—even the synthetic ester type lubricants required additives to make a workable product. So it was that in 1955-56, Dr. Young worked on additives (while working at Sinclair's Harvey Research Center) to improve the anti-wear and defoaming properties of these ester lubricants. Starting with his first love, titanium chemistry, he found a new way to polymerize titanium chelate compounds. Ester soluble and water insoluble titanium polymers were made with molecular weights from 1,500 to as high as 10,000. Such titanium polymers were found to be anti-wear additives, as well as defoamers, in synthetic ester lubricants. Titanium polymers, as additives, are today used in ballistic missiles, prop jet engines, helicopters—anywhere that high temeprature and extreme wear conditions exist.

Following over 30 years in industry as a research scientist (over 260 U.S. patents, and an equal number of foreign patents, 50 scientific publications), Dr. Young retired as Senior Research Associate, Atlantic Richfield Company (formerly Sinclair) to become President of his own consulting firm. He is a Past President of the American Institute of Chemists. ■

Deceased Chemical Pioneers

Unfortunately for society, four AIC Chemical Pioneers have passed away. Their contributions will be long remembered, however.

Oliver W. Burke, Jr.

"for recognizing the importance of type of carbon black to the manufacture of synthetic rubber of high quality and for setting up the cooperative research which enabled scientists to achieve this goal; for discovering how to make a form of silica capable of producing high-tensile GRS; for being one of the great chemical inventors of our time." (Awarded 1971)

Elizabeth Hazen

"for the discovery of the fungal antibiotic "Nystatin" which is an important help to physicins and a boon to mankind." (Awarded 1975)

Percy L. Julian

"for pioneering research in the chemistry of indole derivatives and related alkaloids, including the total synthesis of the drug, physostigmine; for significant advances in the chemistry and manufacture of sterols, progesterone and other sex hormones, hydrocortisone and related anti-inflammatory steroids; for creative inventions leading to practical methods for manufacturing phosphatides, protein products, emulsifiers, adhesives, protective coatings, and other products from soybeans; and for exemplary leadership in science, education and civic affairs, bringing major benefits to mankind." (Awarded 1968)

E. Emmet Reid

"dean of American organic chemists, whose contributions to the knowledge of organic sulfur compounds occupy a classical position in the world's literature." (Awarded 1972)

Other Chemical Pioneers

Regretfully, profiles of the following AIC Chemical Pioneers did not reach AIC Headquarters in time for this special issue.

C. Kenneth Banks

"for pioneering achievement in the design and synthesis of the Promacetin molecule which has contributed effectively in removing the threat of leprosy from the human race; for retaining the power of original thinking in an age of conformity." (Awarded 1971) American Can Corporation

Carl E. Barnes

"for his pioneering work in a broad area of applied chemistry; for his outstanding leadership in industrial chemistry; for the more than 50 patents which he has accumulated, and specifically for his personal contributions to the understanding of the role of oxygen in vinyl polymerizations; for his contributions to the development of ultra-violet absorbing agents and Scotchgard." (Awarded 1966)

Ralph A. Connor

"for pioneering research in academic and industrial chemistry: for inspiring and effective leadership in organizing and administering complex research programs, including those bringing notable advances in catalytic hydrogenation, high polymers, enzymes, propellants, surface-active agents, leather and textile finishes, and agricultural chemicals; and for distinguished service to his community, government and the profession of chemistry." (Awarded 1968) Rohm & Hass Co.

Vladimir Haensel

"for pioneering research in petroleum refining, petrochemical technology, hydrocarbon chemistry, and catalysis; for outstanding leadership in industrial chemistry; for some 200 patents and publications, and for key inventions in the catalytic upgrading of gasoline, the production of triptane, and the employment of multifunctional catalysts to isomerize hydrocarbons." (Awarded 1967)

James D. Idol, Jr.

"for pioneering research in petrochemistry; for creative invention and development leading to a radically new and improved method for manufacturing acrylonitrile, thereby revolutionizing the industry based on this monomer; and for outstanding ability to produce enthusiasm, dedication, and effectiveness in team research." (Awarded 1968) Standard Oil Company of Ohio

Robert M. Joyce

"for his outstanding pioneering research in industrial organic chemistry which, through his work on telomerization, did much to elucidate the mechanism, side reactions and chemistry involved in vinyl polymerization and led to the development of the first successful commercial process for the manufacture of polytetrafluoroethylene; and for his success in encouraging young men to try the unusual rather than to follow the known path." (Awarded 1966)

Percival C. Keith

"for brilliant leadership in the design and erection of the Oak Ridge gaseous diffusion plant, which provided materials for bringing World War II to a successful conclusion, and whose processes are the source of U-235 for present commercial power plants using atomic energy." (Awarded 1973)

Irving E. Levine

"for contributing in a substantial way to the commercially successful manufacture of phthalic anhydride and also isophthalic and terephthalic acids from their respective xylenes." (Awarded 1969)

Wilson C. Reeves

"for pioneering research in the treatment of cotton fabrics to render them more resistant to wrinkling, fire, weather and microorganisms." (Awarded 1976)

William G. Toland

"for contributing in a substantial way to the commercially successful manufacture of phthalic anhydride and also isophthalic and terephthalic acids from their respective xylenes." (Awarded 1969)

A Special Thank You

The American Institute of Chemists plans to distribute this special issue of THE CHEMIST to students, teachers, and interested parties at all levels of education in America. It acknowledges its lasting appreciation to the following employers, of those Chemical Pioneers so identified in this issue, for providing generous financial support without which the widespread distribution of this Bicentennial Issue of THE CHEMIST would not be possible.

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Houston, Texas

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Houston, Texas

Standard Oil Company of Ohio
Cleveland, Ohio

Union Carbide Corporation
New York, New York

Union Oil Company of California
Los Angeles, California

CHEMICAL PIONEERS—AMERICAN INSTITUTE OF CHEMISTS

Bicentennial issue of THE CHEMIST, has been prepared for widespread distribution to the public. We are pleased to provide the correct addresses of the Chemical Pioneers should anyone wish to write directly to them.

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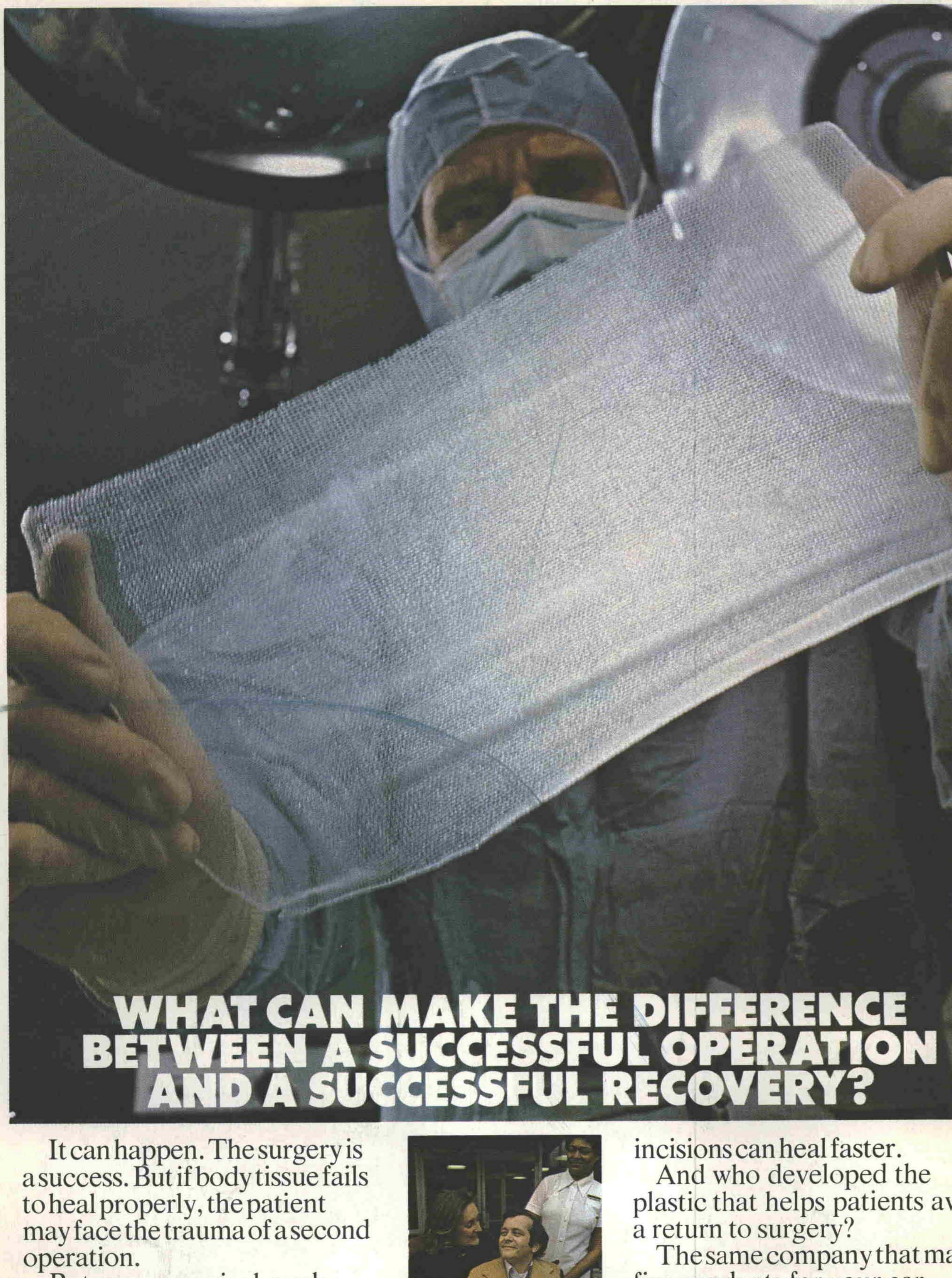

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