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PUB 254

Materials and Molecular Research Division

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December 1978

Volume 2, No. 10

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tory

Season's Greetings

As we approach the end of 1978, we can look back on a year of achievement in MMRD—new people, new programs, and new science have all been added. We look forward with optimism to further developments and new facilities in 1979. The success of MMRD belongs to all of us. Let me take this opportunity to express our gratitude for your contributions and to wish each of you Joyous Holidays and a Happy New Year.

David A. Shirley
David A. Shirley
Division Head

RESEARCH PROFILE

Anthony Evans

STRUCTURAL PROPERTIES OF CERAMICS

Ceramic materials exhibit a variety of unique properties. Amongst these are: (a) deformation resistance and the resultant prospects for good high temperature strength, (b) high hardness and the concomitant abrasion and erosion resistance, (c) unusual electrical properties such as the piezoelectric property used in transducers, and (d) optical transmission capabilities over a range of wavelengths resulting in their use as laser windows, etc. However, when designing components to take advantage of these properties, the intrinsic deficiency of ceramics — their inherent brittleness — has presented an obstacle that is only now being surmounted. The brittleness of ceramics has required both that new design approaches be adopted to ensure structural integrity and that a comprehensive scientific framework for

(Continued on page 4)



VOLLHARDT WINS DREYFUS AWARD

Professor PETER VOLLHARDT is one of the fifteen annual winners of the Dreyfus Foundation Teacher-Scholar Awards for 1978. The Award carries a grant of \$35,000 over a five-year period and is restricted to young faculty working in chemistry, biochemistry, or chemical engineering.

(Continued on page 3)

PUB 254



GARETH THOMAS ELECTED TMS FELLOW

GARETH THOMAS, MMRD Investigator, has been named as one of only five new Fellows for 1979 of the Metallurgical Society of the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME). Induction will occur at the AIME Annual Meeting in New Orleans next February.

THOMAS' election is in recognition of his pioneering work in physical metallurgy. The citation reads, "for applications of transmission electron microscopy to the understanding and improving of structural alloys." He has developed patents to improve the stress corrosion resistance of aluminum alloys and a treatment producing duplex steels of high strength, toughness, and formability.

TMS Fellowship is limited to 100 living members with a maximum annual election of five new members. At the present time less than two percent of the membership of AIME are Fellows. (Last year THOMAS was elected a Fellow of the American Society for Metals (ASM). With this latest honor, he joins a very select group of metallurgists who are Fellows of both societies.)

THOMAS is a professor in the MS&ME Department of UCB and has been associated with the Laboratory since 1961. He is very active professionally with two books and over 200 research articles to his credit and has served in various academic posts of great responsibility.

Earlier this year, Professor THOMAS won the E. O. Lawrence Memorial Award, a first for UC's College of Engineering, and he is currently the General Secretary of the International Federation of Electron Microscopy Societies.

JOLLY WINS MINI-GRANT

A proposal by Professor WILLIAM JOLLY to obtain an automatic lap dissolve slide projector attachment to assist in the teaching of chemistry was one of the summer-fall 1978 mini-grants recently approved.

JOLLY explained that this device allows gradually changing from one slide to the next without darkening of the screen between slides. In effect one slide flows into the next. By coupling this equipment to computer drawn molecular models, it will be possible to show a large group of students changes in the appearance of a molecular structure viewed from different angles.

The equipment can also be effectively used to illustrate successive stages in a chemical reaction. The impression of motion keeps the student alert to the changes which occur, and the still slides emphasize the difference present at specific points along the path of the reaction.

HEARST HAILS HOLIDAY

The most difficult building on the UC campus to decorate, Hearst Mining, is dressed for Christmas. The decorators surmounted the problems of a huge central open space, exceptional height to the skylight ceiling, and interior columns to achieve a remarkably cheerful and pleasing effect.

Visit Hearst Bldg., if you can, during the holidays.

VOLLHARDT (continued)

"How did you get interested in chemistry, PETER?"

"I wasn't doing well in my chemistry class. Somehow the teacher left me confused and bored, but I was determined to get a good grade in the class. In desperation, I obtained several chemistry books and started studying on my own. It was incredible—not only did I begin to understand, I became fascinated. I've been hooked on chemistry ever since. I was about 16 when that occurred."

The Dreyfus Awards were established in 1969 in the name of Camille and Henry Dreyfus, Swiss brothers and founders of the British Celanese and the Celanese Corporation.

"Do you like teaching?"

"Yes, of course, both undergraduate and graduate students. I also like laboratory work, although with a group of 16 coworkers I rarely get a chance to do it these days! Experimenting is a lot like living: looking at things in new ways, challenging accepted ideas, trying different angles, and testing theories. Research opens new doors, different opportunities, if you look at problems with an open mind. Life does that too. I sometimes find it hard to believe I teach and lecture as a job—it doesn't seem like work except for the occasional drudgery of paperwork."

The grants from the Teacher-Scholar Program are awarded to academic institutions for the benefit of young faculty members of "exceptional promise and demonstrated ability in teaching and performing imaginative research." The aim is to make financially possible the development of the recipient's potential both as a teacher and a scholar.

"What are some of the ideas you would like to see incorporated in the teaching of college chemistry?"

"Video-taping lectures so students may review them."

"More sophisticated lab courses for honor students."

"Earlier involvement of students in research. The research environment, the laboratory excitement, the rubbing of shoulders with grad students—these kinds of interactions are important to capture the student's curiosity and open his mind to the vast potential in chemistry."

"I'd like to initiate a program where outstanding chemists such as Nobel winners visit the campus and spend a week entirely arranged by grad students. There should be not only lectures or seminars where

the visitor can make formal presentations, but also personal, informal continuation of the interface at dinner, or while commuting to a concert or symphony in the evening. Students could learn more about the visitor's philosophy of science, indeed, possibly his philosophy of life, his scientific approach, and personal background. This sort of give and take is nearly inaccessible to grad students today."

Four other investigators with MMRD have received this award: They are: ROBERT BERGMAN (1970), YUAN T. LEE (1971), WILLIAM MILLER (1973), and ALEX PINES (1976).

"You accept many invitations to lecture which involves you in time-consuming travel. How can you do this and keep up with the literature in your field?"

"Last year I presented over 50 invited lectures and visited Japan, Brazil, Europe and many places in the United States. The interaction that occurs at such seminars and in the questions and answers after lectures are sometimes more valuable, in my opinion, than reading the literature. In particular, the discussions with researchers are current to the minute—the literature is a year, two years, sometimes even more behind the actual experimentation. Don't misunderstand; of course I read the literature thoroughly, but I feel that personal interaction with leading investigators provides a lot of stimulus as well as keeping you abreast of the work in the field."

PETER VOLLHARDT has many interests outside his profession: he prays for snow like most skiers; he likes music ranging from classical to modern (he played in a rock band as a student); he enjoys theater and opera; and he reads, mainly modern fiction and science fiction.

Looking ahead, PETER expects to continue his study of synthetic transformations, and the mechanisms of catalysis. As he describes his work, the enthusiasm and delight in all of life which is so much a part of this scientist-teacher slips in to add a sprightly touch: "I want to have an impact on chemistry with experiments that are aesthetically pleasing as well as useful. I want not only to solve problems, but also to solve them elegantly."

RESEARCH PROFILE (continued)

assessing the strength capabilities of ceramics be developed. Considerable progress has been achieved in each area within the last five years, although much additional research is required to obtain a thorough comprehension of the structural reliability of ceramic components.

Examples of recent high technology applications for ceramics include: (a) silicon nitride and silicon carbide components for advanced diesel and gas turbine engines, (b) zirconium oxide gas sensors and wire drawing dies, (c) zinc sulfide, potassium chloride, calcium fluoride laser windows, and (d) silica and carbon fiber/graphite thermal protection systems for re-entry vehicles (e.g., the space shuttle). Many more such examples will emerge during the next decade and beyond.

The philosophy adopted in the design of ceramics has been to recognize their brittleness and to design components so that the strength capabilities of the material always exceed the large extreme value of tensile stresses that develop within the component. The latter are calculated using numerical methods (e.g., three-dimensional finite element techniques). The former requires a detailed comprehension of the fracture of brittle materials. Research activity has therefore concentrated, and will continue to concentrate, on the problem of brittle fracture involving considerations of the mechanics of fracture, the effects of microstructure (especially the role of second phases), and the statistics of crack size distributions.

A brief survey of research in brittle fracture pertinent to ceramics, and of future research directions, provides a perspective from which the ceramic research activities at LBL can be reviewed.

It is now recognized that the fracture strength of ceramics depends on

two parameters: the fracture toughness of the material and the size of the flaws that pre-exist in the material. By independently studying the effects of microstructure on these properties, materials with superior mechanical strength can be designed. For example, it has recently been established that two-phase materials containing one constituent that undergoes a martensitic transformation can be appreciably tougher than single-phase ceramics. Exciting developments are anticipated in the martensitic toughening of ceramics. The appreciation of the flaw size dependence of the fracture strength has also led to the development of much improved ceramics. The flaws in ceramics derive primarily from two sources: pores or inclusions introduced during fabrication and surface cracks induced during surface finishing (machining, cutting, or polishing). Studies of the mechanisms of formation of these flaws, coupled with statistical analyses of their influences on strength, have permitted the recent development of very high strength materials, e.g., 200,000 psi for silicon nitride (tested in flexure). Further improvements can be reasonably anticipated in the near future.

The strength of ceramics can (as with all materials) be degraded by various interaction processes. Examples of phenomena that yield strength values lower than those obtained in a simple laboratory flexure test are: (a) statistical effects manifested as a size dependence of strength (i.e., large components are weaker than small components), (b) damage created by projectile impact or thermal shock, (c) formation of cavities during high temperature creep, (d) slow crack growth, and (e) oxidation or corrosion. It is crucial that these phenomena be characterized and understood before a ceramic can be utilized in a structural application.

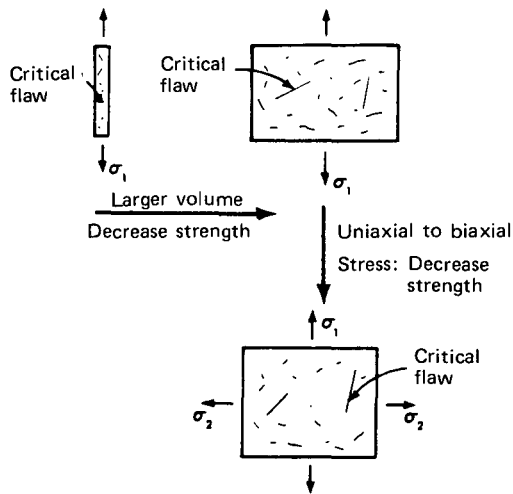


Fig. 1. Statistical effects cause the strength of ceramics to depend on size and stress state.

The statistical effects on strength (Fig. 1) have recently been analyzed in detail using weakest link models, i.e., models which allow fracture to occur from the largest crack suitably oriented with respect to the applied stress. These models permit first order estimates of the strength of actual components from strength data obtained on suitable laboratory samples.

The effects of projectile impact have also begun to emerge through systematic studies of the cracks that form around impact sites (Fig. 2). One very interesting feature of impact problems is that localized plastic flow occurs at the impact site, even

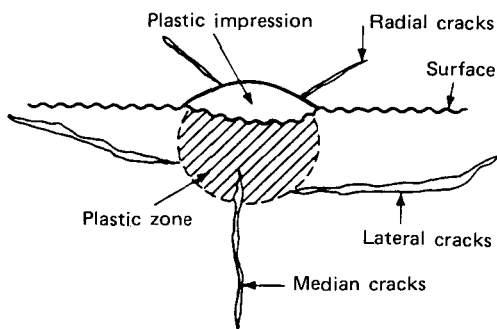


Fig. 2. Projectile impact damage in ceramics median cracks cause strength degradation. Lateral cracks cause erosion.

in the most brittle materials such as glass. This plasticity has a critical influence on crack patterns and on the material parameters that determine the extension of the cracks. This appreciation has led to the identification of materials that are substantially more impact damage resistant (through their toughness and hardness properties) than conventional ceramics.

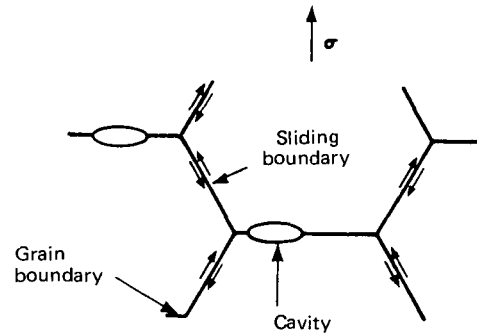


Fig. 3. Cavitation at grain boundaries in ceramics created by grain boundary sliding and vacancy migration.

At very high temperatures, cavities form at grain boundaries following the application of an external stress (Fig. 3). These cavities diminish the lifetime capabilities of a material. Their formation should thus be averted. Recent studies have demonstrated that these cavities form and grow by the transport of vacancies along grain boundaries. Vacancy migration is driven by local stress concentrations that develop due to the sliding of grain boundaries subject to the shear component of the applied stress. The dependence of the cavitation process on grain boundary phenomena indicates a strong dependence on the properties of the boundaries, particularly the presence of non-crystalline phases. The detailed relationships between cavitation and boundary properties are now being investigated.

Research concerned with the mechanical behavior of ceramics will proceed

at LBL along the broad front of requirements noted above, but concentrating at any one time on selected critical uses. The research progress will preface the continued exploitation of ceramics in an increasing range of high temperature applications.



VACUUM TECHNOLOGY COURSE

BOB McALLISTER, WEYLAND WONG, and GLENN BAUM, all support personnel working in Bldg. 62, attended a course in vacuum technology in San Francisco during the recent National Symposium of the American Vacuum Society.

Among the topics covered in the course were: mechanical pumps, diffusion pumps, Getter pumps, ion pumps, total and partial pressure measurement, leak detection, and system design concepts. The course was 4½ days long and each student received a certificate, a textbook, and 2.7 Continuing Education Units (CEU). Course fee of \$300.00 was paid by the Division.

WHAT'S GOING ON?

According to KEN WESTMACOTT, most of the earthmoving activity on the hillside around Bldg. 72 is connected with redeveloping the vacant chicken farm for probable use as a new mechanical yard.

Also underway are the access road to the HVEM service yard and the excavation for the HVEM building foundation.

KEN adds, "According to my present information, actual building of the silo will not begin until February."

BELL WINS GLENN AWARD

ALEXIS BELL has been selected as a co-winner of the R. A. Glenn Award for the best paper pertaining to coal or derived products presented at the Fuel Division Meeting of the American Chemical Society. The award consists of an engraved certificate and a cash prize of \$100.00 for each author.

The co-authors of the report are: D. P. Mobley, S. Salim, K. I. Tanner, and N. D. Taylor.

BELL has prepared a brief synopsis of the prize winning report for our readers:

"Chemical Changes Produced in Coal Through the Action of Lewis Acid Catalysts"

Lewis acid catalysts, such as $ZnCl_2$ and $SnCl_2$, hold the prospect for achieving coal liquefaction at subpyrolysis temperatures ($\geq 350^\circ C$), with only moderate consumption of hydrogen. The purpose of our work has been to establish the effects of Lewis acids on coal and to identify the specific chemical reactions promoted.

Our studies have demonstrated that catalyst activity is critically related to the extent of coal solubilization in benzene and cyclohexane. Very strong acids such as $AlCl_3$, $FeCl_3$, $SbCl_3$, and $HgCl_2$ decrease solubility by promoting polymerization. Weaker acids such as $ZnCl_2$ and $SnCl_2$ enhance SRC solubility and the aliphatic character of the products.

Studies with model compound, resembling the structure of coal, have helped to elucidate the chemistry of liquefaction. We have found that ether and sulfide linkages between aromatic nuclei are readily cleaved by weak acids. The cleavage of aliphatic linkages is more demanding and is sensitive to the nature of nuclei and their substituents. Fused ring aromatic clusters may undergo both hydrogenation and cracking, depending on the acid strength.

FIRE IN LATIMER

Sunday, November 12, there was a fire in 305 Latimer, the temporary laboratory for seven of Professor MUETTERTIES' students.

The main fuel feeding the fire was about seven gallons of KOH-ethanol solution in a plastic barrel used for cleaning glassware. It is unclear how this solution caught fire; but once ablaze, the plastic barrel melted and the KOH-ethanol solution flowed around the central lab bench and near the reagent shelf.

"We know that there were two reactions running, both at some distance from the ethanol bath," said Professor MUETTERTIES. "We recovered both of these intact, and it is certain that they did not initiate the fire."

"I've looked over that lab, thoroughly, looking for any indication of how that fire might have started, with no success," Professor MUETTERTIES added. "We can understand all the damage that occurred, and how it occurred. Although I have, and always have had, reservations about the use of the ethanol bath, it is used extensively in chemistry laboratories throughout the country. My own reservations stem primarily from its danger to human tissue, especially the eyes, and I have cautioned people about it in the past."

Lost in the fire were several pieces of small electrical equipment, a gas chromatograph, three recorders and some precious metal compounds.

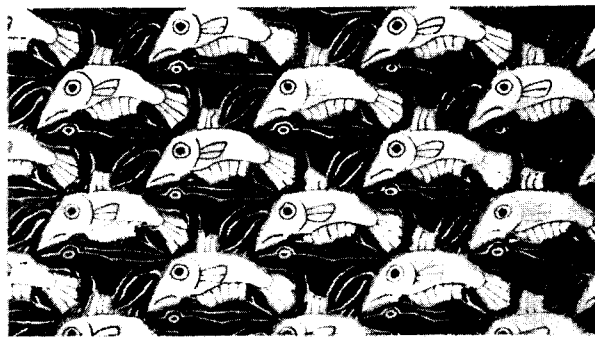
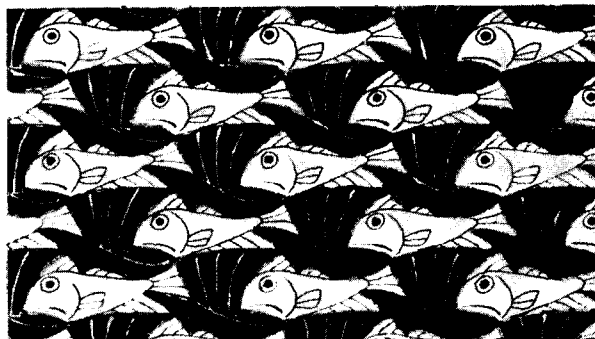
However, many individual pieces of equipment were salvaged by grad students carefully sorting through the fire area. Repair and replacement costs will likely exceed \$50,000, but this is covered by College Insurance. Non-replaceable is the time lost to grad students and post-docs who were working in the area.

--Contributed by Walt Bode

TURNABOUT

Noting that artists frequently borrow from scientists, Dr. RON GRONSKY uses a switch ...

In his introductory graduate course on Materials Science and Engineering, RON uses the drawings of M. C. ESCHER to teach crystallography. Look at the ESCHER figure below and tackle the following: "Specify an appropriate lattice and motif which generate the 'structure' of the drawing."



QUOTES

"The trouble with our time is that the future is not what it used to be."
Paul Valéry

"We will have difficulties as we map our course, and those difficulties are unavoidable. I think they are testimony to the magnitude of the responsibility that this Department has, but we can be assured that we have a mission that is vital to the future security and economic well-being of the United States, and we will carry out that mission."

James Schlesinger

MILLER RESEARCH PROFESSORSHIPS

No less than five MMRD investigators have received, or are scheduled to receive, prestigious Miller Research Professorships within the last three years. They are ALEX PINES, GABOR SOMORJAI, and KENNETH RAYMOND (1977-78), WILLIAM MILLER (1978-79), and ANDREW STREITWIESER (1979-80).

Applications for the 1980-81 academic year are being invited by the Advisory Board of the Miller Institute for Basic Research in Science. Eligibility for these Professorships is restricted to members of the science faculties of the University of California (any campus), but with the research to be conducted at UCB.

The Miller Research Professorship allows the appointees to devote full time and effort to research by declining administrative and teaching assignments during the term of the appointment.

Copies of a brochure describing the opportunities offered by the Miller Institute may be obtained by contacting the Institute on campus, Ext. 2-4088, between the hours of 10 and 4. Applications for the 1980-81 academic year are due by February 1, 1979.

PEOPLE NEWS

JUDY HAYES is the new secretary for ROBERT BRAGG and ANTHONY EVANS. It will be interesting to see how JUDY decorates her office — she is very interested in decoration and design. Some day, if things go right, JUDY hopes to earn her living as an interior decorator.

WILLIAM MILLER and ANDREW STREITWIESER are due congratulations! They have both received Miller Research Professorships — MILLER for the current academic year, and

STREITWIESER for the 1979-80 academic year.

WALT TOUTOLMIN and PHILIP ROSS attended selected symposiums in San Francisco during the recent gathering of the American Vacuum Society.

GAY BRAZIL and her husband repeated their wedding vows in a quiet church service Saturday, December 2, to celebrate their twenty-fifth anniversary. Congratulations!

Three more of our campus support personnel are improving their skills and job value by attending a series of workshop/lectures on University accounting. CAROL HACKER, JUNE SMITH, and DOREEN TUTTLE have completed some twelve hours of class time over a four-week period.

GARETH THOMAS and ANTHONY EVANS were both born in Wales. They grew up within seven miles of each other. Now their offices in the Hearst Mining Building are within seven yards of each other. Small world.

MILTON PICKUS is learning yoga! Responding to an announcement in Currents several weeks ago, MILT has been meeting with a yoga class in Bldg. 90 at 5:15 on Tuesday evenings. He enjoys the sessions and says he does feel more relaxed after the Tuesday meetings.

PHILA ROGERS, formerly a photographer in Bldg. 62, and CAROL FRISCH, the quarterly LBL Newsmagazine reporter with the MMRD beat, are also in the class.

QUOTE

"A society — particularly a democratic society — that is based upon science and technology, but where the citizens are almost totally ignorant of science and technology is heading for disaster." Carl Sagen

WANDERLUST HITS SUPPORT STAFF OF MMRD

It isn't only the scientists and engineers of MMRD who soothe their itchy feet with travel. In MMRD anyone can come down with this restless malady — some examples from vacation travels this year:

KAREN KRUSHWITZ, usually found handling Dr. BREWER's paperwork, slipped away on a visit to FINLAND and RUSSIA.

SANDY STEWART stopped purchasing for the Division and did a bit of personal spending instead: she and her son, SCOTT, took off to ENGLAND and SCOTLAND after an earlier trip to HAWAII.

NANCY WURSCHMIDT didn't leave the country, but found a lot to see and do when she visited LAS VEGAS and then sought some contrast by going to the GRAND CANYON. A trip from the unnatural to the natural!

SANDRA JENNINGS found an exciting and unique solution to vacation time — she took a cruise to the BAHAMAS. That's class!

CORDELLE YODER decided, after hearing again and again about the magnificent fall colors on the East Coast, to see for herself ... She took a long, slow trip through the autumn-decorated Atlantic coast states and then on into CANADA.

And CANADA also attracted ROY McCOLLOUGH and his wife. They drove up to SEATTLE via CRATER LAKE, PETERSON'S ROCK GARDENS, and MARYHILL MUSEUM. Then, after dining in the Space Needle and seeing a dramatic laser light show at the Science Center, they headed for VICTORIA and joined a non-smokers cruise through the STRAITS OF GEORGIA and JUAN DE FUCA for eight uncommonly fine days.

MARY NORTON took her ease in HAWAII and returned as a secretary of another color!

DENISE JENKINS and MAMIE BROWN both wandered down to southern California for a few days visiting with relatives and friends.

JACKIE DENNEY and her family had a marvelous time railroading through FRANCE, SPAIN, GERMANY, and SWITZERLAND. They bought a Europass and used it as both an economical and interesting way to meander through EUROPE. "You really get a feel for the people of a country when you meet and mingle with them on a train," points out Jackie.

MILDREN CHIN and her husband drove to ANAHEIM for a bowling tournament — then visited CATALINA ISLAND.

DEBORAH JEFFREY did most of her wandering nearby as she visited and explored MT. TAMALPAIS, MUIR WOODS, PT. REYES, LAKE TAHOE, and MAGIC MOUNTAIN. Did she pick up any magic on the mountain? She sometimes sparkles!

MARGIE JANZEN flew back to ST. LOUIS, MISSOURI to visit her sister and brother-in-law. She also visited: LAKE OZARK and the ST. LOUIS ARCH. The ARCH is entered by way of a basement museum which was nearly as interesting as the ARCH itself. Naturally she photographed the ARCH — "and my picture is as good as any of the postcard views!" she declares.

SUE KIM has rejoined the MMRD clerical staff after several weeks footloose in EUROPE. She visited SPAIN, ITALY, PORTUGAL, FRANCE, GREECE, SWITZERLAND and ENGLAND, and carried away especially impressive memories of THE ALHAMBRA, THE ACROPOLIS, and STONEHENGE. Another exceptional moment occurred when she climbed a hill outside FLORENCE. Looking down at the city, SUE was delighted to notice that all the roofs were tiled in red. This created a very special effect for the alert viewer.

WANDERLUST (continued)

A personal reaction from SUE: "The Europeans are so proud of their culture and past achievements (and they should be), yet this leads them to tend too much toward looking back to the past. Americans are forward looking. That difference makes me feel good about being an American."

HERB RIEBE returned less than two months ago from a trip to the PEOPLE'S REPUBLIC OF CHINA. HERB made the trip with a tour group — the only available method of travel to CHINA for individuals at this time — of 27 persons. He was most impressed with the country and took many pictures while there. "One thing which invariably attracted a curious crowd, HERB noted, "was instant cameras. Very few Chinese had ever seen instant photography before."

WINNIE HEPPLER got away last March for the dream vacation of a lifetime! She spent four weeks camping and exploring the wild animal preserves in KENYA. A fantastic adventure full of excitement, enchantment and enjoyment. Did you take pictures, WINNIE?

WALTER GIBA flew off to WEST GERMANY where he purchased a Mercedes and shipped it home. Next he visited his brother and other relatives in POLAND where he became a news-maker with the surprise arrival of a letter he had mailed to his brother 28 years earlier.

JOHN HOLTHIUS also headed for EUROPE. He visited both in HOLLAND and BELGIUM before returning to his duties in Bldg. 62.

QUOTE

"All catalysis is pretty much a black art," explains Dr. Eugene Weaver, a Ford Motor Co. emissions planning associate.

LIBRARY NOTES

According to Librarian MARIANNE LARSEN, the following are recent books and journals received in the MMRD Library.

Books

Miller, Stanley L. The Origins of Life on Earth.
QH325 M651 1973.

Sarkar, A. D. Wear of Metals.
TA418 4 S27 1976.

Scully, J. C. The Fundamentals of Corrosion, 2nd edition.
TA462 S437 1975.

Benson, Rowland S. Advanced Engineering Thermodynamics, 2nd edition.
TJ265 B49 1977.

Dowson, D. Elasto-Hydrodynamics Lubrication.
TJ1071 D64 1977.

Journals

Energy Research Digest

Physics Today

DR. RICHARD FULRATH

"I want to pay tribute to PROFESSOR RICHARD M. FULRATH who I knew as an advisor and as a friend over the last seven years of his life. His devotion to teaching was coupled with a personal devotion to his students. As students we first mistook his fierceness for animosity. Near the end we waited for the right moment to speak our last words to him and woke to find him gone --no final look into the heart of the man who terrified us at first and then became part of us, our knowledge and our outlook. It was an honor to have been his student." Quoted from acknowledgments in the Ph.D. thesis by Robert Powell, Jr. (LBL-8219).

LBL REPORTS BY MMRD PERSONNEL

NOTE: All MMRD/LBL reports listed here are available in the reference section of the MMRD Library, Bldg. 62, Rm. 339, or call Marianne Larsen, Librarian, at Ext. 5971 (p.m. only).

UCID-8047: Coal Liquefaction Alloy Test Program Quarterly Progress Report for the Period April 1 to June 30, 1978 ... A. Levy, W. Lochmann, and I. Cornet.

LBL-6693: Transmission Electron Microscopy: Direct Observation of Crystal Structure in Refractory Ceramics ... T. Shaw and G. Thomas.

LBL-7346: An Investigation of a Thermoplastic-Powder Metallurgy Process for the Fabrication of Porous Niobium Rods ... D. R. Nordin (M.S. thesis).

LBL-7680: Study by Elastic Theory of the Clustering of Solute Atoms During the Early Stage of Solid Solution Decomposition ... M. Hong (M.S. thesis).

LBL-7696: Imaging of Thin Intergranular Phases by High Resolution Electron Microscopy ... O. L. Krivanek, T. M. Shaw and G. Thomas.

LBL-8005: Temperature-Programmed Desorption and Reaction of CO and H₂ on Alumina-Supported Ruthenium Catalyst ... G. G. Low (M.S. thesis).

LBL-8028: Microstructure of Hot-Pressed and Sintered Silicon Nitrides ... O. L. Krivanek, T. M. Shaw and G. Thomas.

LBL-8050: Laser Photochemical Reaction Dynamics in Formaldehyde ... M. B. Zughul (Ph.D. thesis).

LBL-8066: Effect of Mechanical Discontinuities on the Strength of Polycrystalline Aluminum Oxide ... J. S. Wallace (M.S. thesis).

LBL-8067: Calculation of Siegert Eigenvalues for Molecular Systems: Results for He(2¹,³S) + H ... A. D. Isaacson and W. H. Miller.

LBL-8073: Diatomic Sulfur: Low Lying Bound Molecular Electronic States of S₂ ... W. C. Swope, Y.-P. Lee, and H. F. Schaefer III.

LBL-8088: The Oxidizing Behavior of Some Platinum Metal Fluorides ... L. Graham (Ph.D. thesis).

LBL-8097: Three Isomers of the Al-C₂H₂ System ... M. Trenary, M. E. Casida, B. R. Brooks, and H. F. Schaefer III.

LBL-8179: Theoretical and Experimental Study of the Dynamic Behavior of a Nonlinear Fabry-Perot Interferometer ... T. Bischofberger and Y. R. Shen.

LBL-8180: A Nonlinear Fabry-Perot Filled with CS₂ and Nitrobenzene ... T. Bischofberger and Y. R. Shen.

LBL-8209: Thermal Rate Constants, Energy Dependence and Isotope Effect for Halogen-Hydrogen-Halide Reactions ... C.-C. Mei and C. B. Moore.

LBL-8213: Vibrational Relaxation of HF (v = 3, 4) by H₂, D₂ and CO₂ ... D. J. Douglas and C. B. Moore.

LBL-8214: Tris(hexamethyldisilylamido) Uranium(III); Preparation and Coordination Chemistry ... R. A. Anderson.

LBL-8216: Entrance Region (Lévéque-like) Mass Transfer Coefficients in Packed Bed Reactors ... P. Fedkiw and J. Newman.

LBL-8219: Phase Equilibria in the PbO-Al₂O₃ System ... B. R. Powell, Jr. (Ph.D. thesis).

LBL-8222: Light Scattering Studies of Solids and Atomic Vapors ... T.-C. Chiang (Ph.D. thesis).

LBL-8230: The Synthesis and Structure of Di-*n*-Propylammonium Ethoxybis (DI-*n*-Propylmonothiocarbamate)dioxo-uranate(VI). A Mixed Chelate Alkoxide of Uranium ... *D.L.Perry, D.H.Templeton and A.Zalkin.*

LBL-8231: Statistical Thermodynamics of Dissociating Gases and Plasmas ... *K.S.Pitzer.*

LBL-8235: Electronic Structure of Homoleptic Transition Metal Hydrides: TiH_4 , VH_4 , CrH_4 , MnH_4 , FeH_4 , CoH_4 , NiH_4 ... *D.M.Hood, R.M.Pitzer, and H.F.Schaefer III.*

LBL-8241 Abstract: Recent Developments in the Theory of Electronically Non-Adiabatic Processes ... *W.H.Miller.*

LBL-8242 Abstract: Radiation Chemistry of Peptides and Protein in Relation to the Radiation Sterilization of High-Protein Foods ... *W.M.Garrison.*

LBL-8249: Energy Transfer in One-Dimensional Substitutionally Disordered Systems. II. Experimental Results for 1,2,4,5-Tetrachlorobenzene ... *D.A.Zwemer and C.B.Harris.*

LBL-8255: On the Periodic Orbit Description of Tunnelling in Symmetric

and Asymmetric Double-Well Potentials ... *W.H.Miller.*

LBL-8256: Infrared Laser Induced Chemical Reactions: Calculations for $X + H_2 \rightarrow HX + X$... *A.L.Orel and W.H.Miller.*

LBL-8262: A Solid State Probe for SO_2/SO_3 Based on Na_2SO_4 -I Electrolyte ... *K.T.Jacob and D.B.Rao.*

LBL-8281: The Oxidation of Uranium(IV) by *N*-phenylbenzohydroxamic Acid and the Structure of the Reaction Product: Chlorodioxo-*n*-phenylbenzohydroxamato-bis(tetrahydrofuran)uranium(VI) ... *W.L.Smith and K.N.Raymond.*

LBL-8283: Gas Flow Through Porous Barriers ... *N.S.Jacobsen (M.S. thesis).*

LBL-8284: Transport Equations for a Mixture of Two Binary Molten Salts in a Porous Electrode ... *R.Pollard and J.Newman.*

LBL-8385: Spectrum of the Cosmic Background Radiation ... *D.P.Woody and P.L.Richards.*

LBL-8337: Response to Comments on "Kinetics of Endothermic Decomposition Reactions. 2. Effects of Solid and Gaseous Products" ... *D.Beruto and A.W.Searcy.*

CALENDAR

Dec. 25 - Jan. 1: Holidays

SURFACE SCIENCE AND CATALYSIS SEMINARS, 1:00 p.m., Bldg. 62, Rm. 203.

Jan. 10: "Transformation of Organic Compounds Mediated by Mono- and Bi-nuclear Cobalt Complexes," *R.Bergman, University of California, Berkeley.*

Jan. 12: "Semi-conductor Photoelectro Chemistry: Chemistry Derivi-

tized Photoelectrodes," *Mark Wrighton, MIT.*

Jan. 17: "Underground in situ Energy Recovery Schemes and Catalytic Processes: Some Interfaces," *P. B. Vernuto, Mobil Research & Development Corp.*

Jan. 24: "CO Oxidation Over Platinum," *J.Wei, MIT.*

Jan. 22: Poster displays due — deliver to Loretta Lizama, Bldg. 62, Rm. 249.

MMRD NEWSLETTER

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Editor: Loretta Lizama.....(5842) Writer/Editor: Roy McCollough...(6062)
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