



AUTHORS — APRIL 1974

FUSION REACTOR MATERIALS

PREFACE

Robert J. Teitel (BS, Purdue University, 1944; ScD, Massachusetts Institute of Technology, 1948) is director of the Fusion Reactor Department at KMS Fusion, Inc. For the past year and a half, his interests have been related to all aspects of fusion-reactor technology with special emphasis on materials. He has been involved in nuclear-reactor research and development for 26 years. His experience includes liquid metal reactor development, nuclear space power system development, nuclear vulnerability and hardening of missiles, and laser-fusion reactor development.

Robert J. Teitel



MATERIALS PROBLEMS IN THE DESIGN OF MAGNETICALLY CONFINED PLASMA FUSION REACTORS

A. P. Fraas

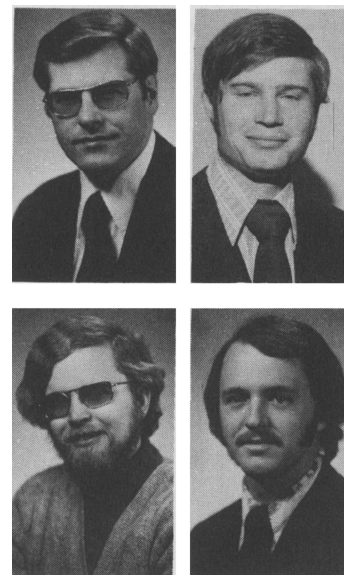
Arthur P. Fraas (MS, aeronautical engineering, New York University, 1943), presently associate director of the Reactor Division, Oak Ridge National Laboratory, has worked on a wide variety of aircraft, marine, and central station power plants. He joined the Oak Ridge National Laboratory in 1950 and for the past five years has spent about half his time assisting the Thermonuclear Division in the conceptual design of full-scale fusion-reactor power plants.



RADIATION DAMAGE LIMITATIONS IN THE DESIGN OF THE WISCONSIN TOKAMAK FUSION REACTOR

*G. L. Kulcinski
R. G. Brown
R. G. Lott
P. A. Sanger*

Gerald L. Kulcinski (top left) (PhD, nuclear engineering, University of Wisconsin, 1965) is an associate professor of nuclear engineering at the University of Wisconsin and the director of the Wisconsin Fusion Reactor Design Study Project. He has conducted research on the effects of radiation on metals at the Battelle Northwest Laboratories from 1965-1971, and his current interests lie with the technological problems associated with the production of power from thermonuclear fusion reactions. Robert G. Brown (top right) (MS, nuclear engineering, University of Wisconsin, 1973) is presently working at Westinghouse Advanced Reactors Division in the Thermal Analysis Group for the Fast Flux Test Facility. Randy G. Lott (bottom left) (MS, nuclear engineering, Michigan, 1972), a graduate student in nuclear engineering at the University of Wisconsin, is engaged in high-energy heavy-ion simulation of neutron damage in pure metals. Phillip A. Sanger (bottom right) (MS, nuclear engineering, University of Wisconsin,

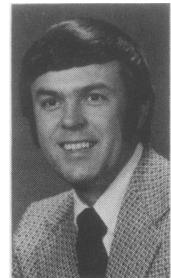
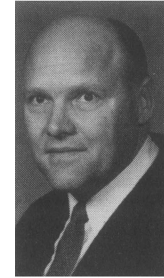


1972), currently a graduate student at Wisconsin, is engaged in research on high-energy proton damage to niobium-titanium superconductors at liquid-helium temperatures.

THE RELEVANCE OF VARIOUS NEUTRON SOURCES TO FUSION-REACTOR RADIATION EFFECTS

Clinton Logan (top) (MS, University of California), of the Research Engineering Division at Lawrence Livermore Laboratory, has performed analytical and experimental work on fusion reactor radiation effects. John Anderson (center) (PhD, University of California), division leader of the Experimental Physics Division at Lawrence Livermore Laboratory, is a fellow of the American Physical Society and a co-recipient of the APS Bonner Prize for 1972. Zuhair Munir (bottom) (PhD, University of California) is Professor of Materials Science in the Department of Mechanical Engineering at the University of California, Davis. His interests include corrosion processes and surface properties.

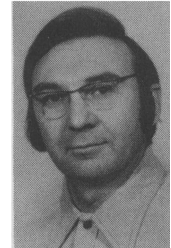
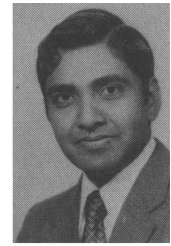
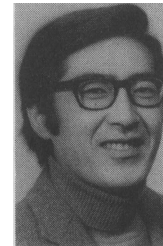
*C. M. Logan
J. D. Anderson
Z. A. Munir*



IMPURITY REDISTRIBUTION AROUND VOIDS IN ION-BOMBARDED VANADIUM

The authors are members of the Kinetics Group in the Materials Science Division of Argonne National Laboratory. P. R. Okamoto (top left) (PhD, engineering science, University of California, Berkeley, 1970) is currently interested in high-temperature radiation effects in metals and alloys. A. T. Santhanam (top right) (PhD, metallurgy, University of Florida, 1971) is presently involved in studies of radiation effects in fusion-reactor materials. H. Wiedersich (bottom left) (Dr. rer. nat., University of Göttingen, Germany) is the leader of the Kinetics Group. His main interests are defects and their influence on physical properties of solids. A. Taylor (bottom right) (PhD, metallurgy, University of Birmingham, United Kingdom, 1958) is currently working in the area of heavy-ion radiation-damage simulation studies.

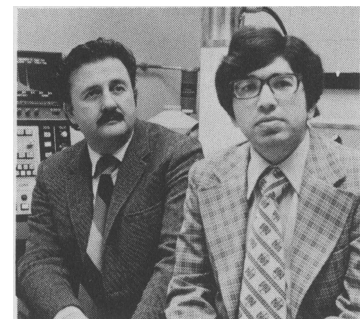
*P. R. Okamoto
A. T. Santhanam
H. Wiedersich
A. Taylor*



STABILITY OF THE DEFECT STATE IN NEUTRON-IRRADIATED MOLYBDENUM

V. K. Sikka (right) (PhD, University of Cincinnati, 1973) is a research associate at the University of Cincinnati. His interests include irradiation effects areas, as well as the high-temperature oxidation behavior of metals and alloys. J. Moteff (PhD, University of Cincinnati, 1965), professor of materials science, joined the Materials Science and Metallurgical Engineering Department of the University of Cincinnati in 1970 following his 18 years association with the General Electric Company, initially with the Aircraft Nuclear Propulsion Program and then later with the Nuclear Materials and Propulsion Operation. In addition to his teaching responsibilities, he is conducting research in the areas of irradiation effects to metals and alloys and in the correlation of the substructure with the elevated-temperature mechanical properties of metals and alloys.

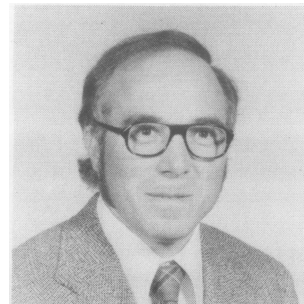
*V. K. Sikka
J. Moteff*



TEM INVESTIGATION OF 14-MeV NEUTRON DAMAGE

K. L. Merkle

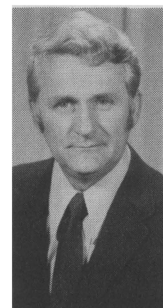
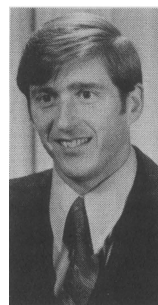
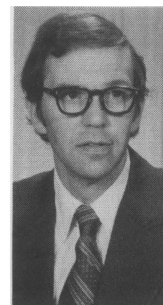
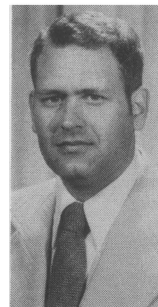
K. L. Merkle (PhD, physics, University of Stuttgart, 1959) is group leader of the Charged-Particle Irradiation Group, Materials Science Division, Argonne National Laboratory. His main areas of interest are atomic collisions in solids and basic radiation damage in metals.



EFFECT OF HELIUM ON THE FATIGUE BEHAVIOR OF THE MOLYBDENUM-BASE ALLOY TZM AT 900°C

*D. J. Michel
C. Z. Serpan, Jr.
H. H. Smith
A. G. Pieper*

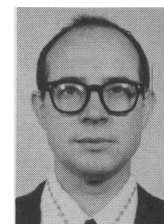
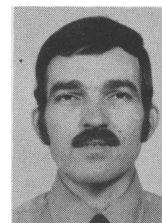
D. J. Michel (top left) (PhD, The Pennsylvania State University, 1968) is head of the High Temperature Metals Section, Reactor Materials Branch, Metallurgy Division, Naval Research Laboratory. He is currently directing and conducting research on the fatigue and flow behavior of reactor materials with particular emphasis on the effects of helium and neutron irradiation. C. Z. Serpan, Jr. (top right) (BS, Ohio University, 1956) is a research chemist with the Reactor Materials Branch, NRL. His experience includes research concerning neutron dosimetry, spectrum analysis, and power reactor surveillance, and he is currently studying the effects of helium in reactor materials. H. H. Smith (bottom left) University of Missouri-Rolla, 1959) is a research metallurgist with the Reactor Materials Branch, NRL. His previous work includes research on the effects of environment and temperature on the fatigue behavior of metals. He is currently studying the effects of helium and neutron irradiation on the fatigue and flow behavior of reactor materials. A. G. Pieper (bottom right) (MS, University of Wisconsin, 1947) is a research physicist with the Cyclotron Branch, Nuclear Sciences Division, NRL. He is presently engaged in the application of nuclear techniques to the study of helium effects in materials.



THERMAL AND ELECTRICAL CONDUCTIVITIES AND SEEBECK COEFFICIENTS OF UNIRRADIATED AND IRRADIATED GRAPHITES FROM 300 TO 1000°K

*J. P. Moore
R. S. Graves
D. L. McElroy*

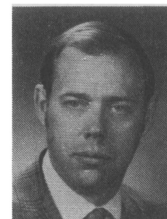
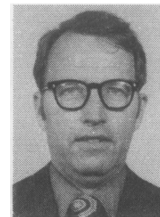
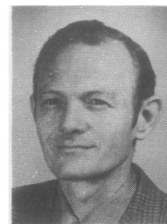
J. P. Moore (top) (MS, physics, Auburn University, 1963) is a physicist in the Physical Properties Group, Metals and Ceramics Division, Oak Ridge National Laboratory. His current interests are in the thermal conductivity of metals and insulators. R. S. Graves (center) (University of Tennessee) is a technologist in the Physical Properties Group and is certified as an engineering technician. He is in total charge of several aspects of laboratory operations. D. L. McElroy (bottom) (PhD, University of Tennessee, 1957) is the leader of the Physical Properties Group, Metals and Ceramics Division, Oak Ridge National Laboratory. His interests include all phases of conduction in a multitude of solids. He is on the committee of the International Thermal Conductivity Conference and is a past recipient of the Thermal Conductivity Award for consistent effort in the field.



THERMAL CONDUCTIVITY OF ORIENTED FIBROUS CARBON INSULATION FROM 300° TO 1300°K IN NITROGEN AND ARGON AT ONE ATMOSPHERE

*T. G. Godfrey
D. L. McElroy
Z. L. Ardary*

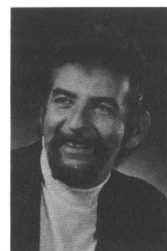
T. G. Godfrey (top) (MS, ceramic engineering, Clemson University, 1959), associate metallurgist in the Physical Properties Group, Metals and Ceramics Division, Oak Ridge National Laboratory, has worked on the development of advanced fuels in the Ceramics Laboratory and is presently involved in the measurement of thermal transport properties of a wide range of materials of interest to nuclear technology. D. L. McElroy (center) (PhD, University of Tennessee, 1957) is the leader of the Physical Properties Group, Metals and Ceramics Division, Oak Ridge National Laboratory. His interests include all phases of conduction in a multitude of solids. He is on the committee of the International Thermal Conductivity Conference and is a past recipient of the Thermal Conductivity Award for consistent effort in the field. Z. L. Ardary (bottom) (BS, chemical engineering, Tennessee Technological University, 1952) has been associated with the Development Division at the Union Carbide Oak Ridge Y-12 Plant since 1952. He is presently a supervisor in the Development Division, responsible for low-density structures.



EFFECTS OF NEUTRON IRRADIATION ON THE SUPERCONDUCTING PROPERTIES OF NbTi AND Nb₃Sn MULTIFILAMENTARY COMPOSITES

*Don M. Parkin
Donald G. Schweitzer*

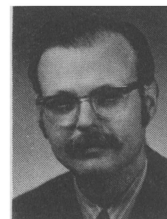
Don M. Parkin (left) (PhD, physics, University of Utah, 1970) has been at Brookhaven National Laboratory since 1970. He is working in two areas of radiation effects in superconductors and is in charge of the CTR materials radiation effects program in the Applied Sciences Department. Donald G. Schweitzer (PhD, chemistry, Syracuse University, 1955) has been at Brookhaven National Laboratory since 1955, where he is a member of the Superconductivity Group and is in charge of the Radiation Effects Group in the Applied Sciences Department



PRELIMINARY ASSESSMENT OF CORROSION PRODUCT TRANSPORT IN FUSION REACTORS

*A. B. Johnson, Jr.
W. F. Vogelsang*

A. B. Johnson, Jr. (left) (PhD, fuel technology, University of Utah, 1958) is with Battelle Northwest Laboratories. His interests have included studies of corrosion in nuclear systems, including effects of radiation on corrosion processes. He has spent February-August, 1973 on the University of Wisconsin Nuclear Engineering Staff working on fusion reactor design, on a faculty interchange program. William F. Vogelsang (PhD, physics, University of Pittsburgh) is an associate professor of nuclear engineering at the University of Wisconsin. He has worked with critical assemblies and neutron diffraction. His current research interests are in the fueling, tritium handling, and safety problems of fusion reactors.



FUSED-SALT CORROSION AND ITS CONTROL IN FUSION REACTORS

S. Cantor
W. R. Grimes

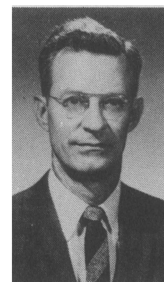
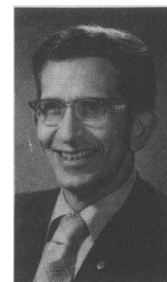
Stanley Cantor (left) (PhD, physical chemistry, Tulane University, 1955) has been employed at Oak Ridge National Laboratory since 1955. His primary interests are in the physicochemical behavior of molten salts and their application to fission and, now, fusion reactors. W. R. Grimes (MS, physical chemistry, Purdue University, 1942) is a program director in the Chemical Technology Division of Oak Ridge National Laboratory. He has made contributions to several areas of the nuclear energy effort, but his primary interests for nearly 25 years has been use of molten salts in fission- and (more recently) in fusion-reactor systems.



THE PERMEATION OF HYDROGEN ISOTOPES THROUGH STRUCTURAL METALS AT LOW PRESSURES AND THROUGH METALS WITH OXIDE FILM BARRIERS

R. A. Strehlow
H. C. Savage

Richard A. Strehlow (left) (PhD, chemistry, University of Illinois, 1956) has been a staff member of the Oak Ridge National Laboratory since 1956. He served as project chemist for the Controlled Thermonuclear Research Program at ORNL from 1959-1967. Since then, he has contributed to programs of the Y-12 Plant and to the Molten Salt Breeder Reactor Program of ORNL. H. Clifton Savage (BS, chemical engineering, Georgia Institute of Technology, 1942) has been at Oak Ridge National Laboratory since 1946. He has been active in reactor materials research and development with special interest in radiation effects on reactor structural materials and fuels.



EFFECTIVENESS OF TRITIUM REMOVAL FROM A CTR LITHIUM BLANKET BY COLD TRAPPING SECONDARY LIQUID METALS Na, K, AND NaK

K. Natesan
D. L. Smith

K. Natesan (left) (PhD, metallurgy and materials science, Carnegie-Mellon University, 1969) and D. L. Smith (PhD, nuclear engineering, Iowa State University, 1966) are in the Materials Science Division at Argonne National Laboratory. The authors are presently involved in various aspects of the corrosion and mechanical behavior of liquid metal fast breeder reactor materials in a sodium environment.

