Fusion technology™

AUTHORS — MARCH 1990

JAPANESE FUSION RESEARCH: ACTIVITIES IN FUSION NUCLEAR TECHNOLOGY

PART I: OVERVIEW

1. HISTORY AND ORGANIZATION OF FUSION RESEARCH AND DEVELOPMENT IN JAPAN

Akira Oikawa

Akira Oikawa (degree, mechanical engineering, Ibaraki University, Japan, 1971) has worked for Hitachi Kizai Kogyo and the Japan Atomic Energy Research Institute (JAERI). He has been with JAERI's Large Tokamak Program Division since 1989.

2. NUCLEAR FUSION RESEARCH SUPPORTED BY THE SCIENCE AND TECHNOLOGY AGENCY AND THE MINISTRY OF INTERNATIONAL TRADE AND INDUSTRY

Akio Kitsunezaki

A photograph and a biography for **Akio Kitsunezaki** were not available at publication time.

3. NUCLEAR FUSION RESEARCH IN JAPANESE UNIVERSITIES SUPPORTED BY MONBUSHO

Takashi Shibasaki

Takashi Shibasaki is a unit chief in the Research Institute Division, Science and International Affairs Bureau, of Monbusho (the Japanese Ministry of Education, Science, and Culture). He has been involved in policy making on nuclear fusion research in Japanese universities.

4. FUSION NUCLEAR TECHNOLOGY RESEARCH AND DEVELOPMENT IN JAPAN

Haruki Madarame

Haruki Madarame (Dr. Eng., University of Tokyo, Japan, 1976) is an associate professor in the University of Tokyo Nuclear Engineering Research Laboratory. His current interests include various aspects of blanket and first-wall engineering, such as liquid-metal magnetohydrodynamics and first-wall behavior during plasma disruption.

PART II: FACILITIES AND ACTIVITIES IN FUSION NUCLEAR TECHNOLOGY

1. HOKKAIDO UNIVERSITY

Toshiro Yamashina
Tomoaki Hino
Yuko Hirohata
Shin Fukuda
Masao Hashiba
Hideki Minagawa

Photographs and biographies for **Toshiro Yamashina, Tomoaki Hino, Yuko Hirohata, Shin Fukuda, Masao Hashiba,** and **Hideki Minagawa** were not available at publication time.

2. TOHOKU UNIVERSITY

Saburo Toda

Saburo Toda (Dr. Eng., mechanical engineering, University of Tokyo, Japan, 1968) is a professor in the Department of Nuclear Engineering at Tohoku University. He has worked on reactor thermohydraulics, reactor safety, and thermal and structural design of fusion reactors.

3. THE UNIVERSITY OF TSUKUBA

Hideki Nariai

Hideki Nariai (BS, 1962; MS, 1964; and PhD, 1967, mechanical engineering, University of Tokyo, Japan) is a professor in the Institute of Engineering Mechanics at the University of Tsukuba. He worked at the Ship Research Institute as a research engineer for nuclear ships from 1967 to 1980. His primary interest is in thermal hydraulics of nuclear and fusion reactors.

4. THE UNIVERSITY OF TOKYO

Takayuki Terai
Satoru Tanaka
Toshiyuki Takagi

Takayuki Terai (top) [BS, 1978; MS, 1980; and PhD, 1983, nuclear engineering, University of Tokyo (UT), Japan] is an associate professor in the Department of Nuclear Engineering at UT. His current interest in fusion technology is materials science for fusion reactors, including tritium behavior in breeding materials and radiation damage. He is also interested in research and development on new materials such as high-technetium oxide superconductor and graphite intercalation compounds. **Satoru Tanaka** (center) (BS, 1972; MS, 1974; and PhD, 1977, nuclear engineering, UT, Japan) is an associate professor in the Nuclear Engineering Research Laboratory at UT. His current interest is fusion reactor fuel cycle, especially tritium technology, tritium recovery from breeders, and plasma/first-wall fuel dynamics. **Toshiyuki Takagi** (bottom) (BS, 1977; MS, 1979; and PhD, 1982, nuclear engineering, UT, Japan) is an associate professor in the Nuclear Engineering Research Laboratory at UT. He currently works on applied electromagnetics in nuclear fusion and superconducting magnet technologies.

5. TOKYO INSTITUTE OF TECHNOLOGY

Masanori Aritomi

Masanori Aritomi (no photograph available) (BS, mechanical engineering, 1970; MS, nuclear engineering, 1972; and PhD, nuclear engineering, 1977, Tokyo Institute of Technology, Japan) worked as a research associate in the Heat Engineering

Division, Research Laboratory for Nuclear Reactors, at the Tokyo Institute of Technology from 1975 to 1983. He is currently an associate professor at the same institute.

6. NAGOYA UNIVERSITY

Kenji Morita

Kenji Morita (Dr. Eng., nuclear engineering, Osaka University, Japan, 1970) is a professor in the Department of Crystalline Materials Science at Nagoya University. His main interests are fundamentals and applications of ion beam/material interactions. He is currently interested in plasma/material interactions in nuclear fusion research.

7. KYOTO UNIVERSITY

Kiyoshi Yoshikawa

Kiyoshi Yoshikawa (Dr. Eng., nuclear engineering, Kyoto University, Japan, 1974) is an associate professor at the Kyoto University Institute of Atomic Energy. He held a visiting appointment at Lawrence Livermore National Laboratory in 1978 and then was at Lawrence Berkeley Laboratory until March 1980. His main interests are direct energy conversion, reactor-relevant technology, and fusion reactor design.

8. OSAKA UNIVERSITY

Akito Takahashi

Akito Takahashi (BE, electrical engineering, 1963; MS, 1965, and PhD, 1974, nuclear engineering, Osaka University, Japan) is an associate professor at Osaka University, where he is scientific director and head of the operation crew of the Osaka University intense 14-MeV neutron source facility, Oktavian.

9. KYUSHU UNIVERSITY

Takeo Muroga

Takeo Muroga (MS, 1976, and PhD, 1979, nuclear engineering, University of Tokyo, Japan) is an associate professor at the Research Institute for Applied Mechanics, Kyushu University. His present research activities are mainly in radiation damage of fusion reactor materials. In 1988, he spent 4 months at Pacific Northwest Laboratory assigned to the U.S.–Japan collaboration on the Fast Flux Test Facility. His work also involves plasma/material interactions. He is working on materials testing experiments using the high-field superconducting tokamak TRIAM-1M.

10. TOYAMA UNIVERSITY

Kuniaki Watanabe

Kuniaki Watanabe (Dr. Eng., vacuum science and technology, Hokkaido University, Japan, 1978) is a professor at the Tritium Research Center at Toyama University. He has worked in the field of surface chemistry and vacuum science for more than 20 years. His current interests include hydrogen (isotope)/material interactions and tritium technology.

11. JAPAN ATOMIC ENERGY RESEARCH INSTITUTE

Masahiro Seki
Hiroshi Yoshida
Tomoo Nakamura
Hitoshi Watanabe
Hiroshi Kudo





Masahiro Seki (top right) (BS, 1969, and Dr. Eng., 1982, nuclear engineering, University of Tokyo, Japan) is head of Plasma Heating Laboratory I in the Department of Thermonuclear Fusion Research at the Japan Atomic Energy Research Institute (JAERI). He is currently involved in research on plasma-facing components for the Fusion Experimental Reactor and the International Tokamak Experimental Reactor. **Hiroshi Yoshida** (top left) (PhD, nuclear engineering, Tokyo Institute of Technology, Japan, 1971) is a research engineer at the JAERI Tritium Engineering Laboratory. He has been engaged in research on uranium enrichment by gaseous diffusion, spent-fuel off-gas treatment, and fusion fuel cycles and blankets. **Tomoo Nakamura** (center right) (BS, nuclear physics, Kyoto University, Japan, 1957) is head of Fusion Reactor Physics Laboratory in the Department of Reactor Engineering at JAERI. He has been working in the area of experimental research on fusion neutronics using a 14-MeV neutron source, FNS, and is the leader of the JAERI/U.S. Department of Energy collaborative program on fusion blanket neutronics. **Hitoshi Watanabe** (bottom left) (BS, metallurgy, Tohoku University, Japan) is manager of the Material Processing and Qualification Laboratory in the Department of Fuels and Materials Research at JAERI. He worked in the field of nuclear fuel processing and properties until 1981. His current research interests include breeding materials and ceramics for fusion reactors, especially the processing, characterization, and analysis of the radiation effects of lithium ceramics. **Hiroshi Kudo** (bottom right) (MS, 1967, and DSc, 1971, chemistry, Tohoku University, Japan) is head of the Isotope Research and Development Division of JAERI. He is involved in the technology of tritium production and the chemical behavior of tritium in fusion reactor materials.

12. MITSUBISHI HEAVY INDUSTRIES, LTD., AND MITSUBISHI ATOMIC POWER INDUSTRIES, INC.

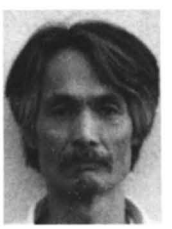
Naoto Asami
Mitsuru Tomita
Kazuhiro Nagashima
Katsusuke Shimizu
Kimihiro Ioki
Masao Yamada
Hiroaki Akiyama



Naoto Asami (top) (BS, physics, Gakushuin University, Japan, 1961; PhD, nuclear engineering, University of Tokyo, Japan, 1986) is deputy general manager of advanced nuclear systems engineering and group manager of the fusion power engineering group at Mitsubishi Heavy Industries (MHI). He is also deputy general manager of the Mitsubishi Fusion Center (MFC). He was manager of the Fusion Development Section at Mitsubishi Atomic Power Industries (MAPI) from 1974 to 1979. He directed the project management for the JFT-2M, JT-60, JT-60U, Fusion Experimental Reactor (FER)/International Thermonuclear Experimental Reactor (ITER), and Large Helical Device (LHD) projects and coordinated research and development (R&D) related to the mechanical and structural components of fusion devices and fusion fuel cycle systems. **Mitsuru Tomita** (center) (BS, mechanical engineering, 1971, and MS, nuclear engineering, 1973, Tokyo Institute of Technology, Japan) is a project manager with advanced nuclear systems engineering at MHI and is deputy manager of the JT-60, JT-60U, FER/ITER, and LHD projects at the MFC. He is responsible for directing activities related to fusion reactor systems and design studies, mechanical and structural engineering of vacuum vessels, plasma-facing components, blanket and fueling components, and their R&D. **Kazuhiro Nagashima** (bottom) (MS, University of Osaka, Japan, 1974) works at MHI where he was engaged in the design and development of a pressurized water reactor power plant system. Since 1988 he has been engaged in tritium and blanket

technology. He is assistant manager of the fusion power engineering group in nuclear energy systems at MHI and is manager of the tritium technology group at the MFC. He was responsible for the planning of the FER and related R&D. **Katsusuke Shimizu** (top right) (BS, 1981, and MS, 1983, plasma physics, Keio University, Japan) studied transport processes due to instabilities in plasmas from 1981 to 1986 at Keio University. He is a member of the fusion power engineering group at MHI and is also a member of Engineering Sections A and D at the MFC. He has worked on the design of a vacuum vessel and first wall for fusion devices since 1986. **Kimihiro Ioki** (top left) (MS, nuclear physics, 1972; PhD, nuclear engineering, 1988, University of Tokyo, Japan) is coordinator of the MAPI fusion development team and is manager of Engineering Section D (vacuum vessel, plasma-facing component, and blanket) at the MFC. He was a research scientist for the Japan Atomic Energy Research Institute team, Doublet-III (General Atomic). He has been the assistant director of Mitsubishi's JT-60U project team since 1988. He has worked on vacuum vessel and first-wall technology for JFT-2M, JT-60, JT-60U, and FER. **Masao Yamada** (bottom right) (BS, physics, Science University of Tokyo, Japan, 1967) has worked for MAPI in the area of fusion design since 1973. During 1986–87 he was a member of the structure design group of the FER design team and in 1988 served with the structure design unit of the ITER joint working group. He is manager of the MAPI fusion development team and of Engineering Section A (system group) at the MFC. He is responsible for the planning and system design of the FER and LHD. **Hiroaki Akiyama** (bottom left) is senior engineer of the applied engineering team, Ohmiya Technical Institute, MAPI. He has worked on the development of ice pellets and lithium ceramics in the field of fusion fuel materials since 1975.



13. TOSHIBA CORPORATION

Yoshio Sawada
Ken-ichi Kakizawa

Yoshio Sawada (top) (BS, 1960, and PhD, 1975, electrical engineering, Tokyo University, Japan) joined Toshiba Corporation in 1960. He has been manager of the advanced engineering department at the Heavy Apparatus Engineering Laboratory, Toshiba Corporation, since 1975, and a fellow specialist since April 1989. **Ken-ichi Kakizawa** (BS, electrical engineering, Nagoya Institute of Technology, Japan, 1963; MS, nuclear engineering, Osaka University, Japan, 1965) is the senior manager of the Fusion Technology Development Office at Toshiba Corporation. He has worked in the area of nuclear energy development, including boiling water and fast breeder reactors, and is currently engaged in the development of fusion technolgoy.


14. HITACHI, LTD.

Nobuyuki Morino
Taro Iwamoto
Yoshitaka Gotoh

Nobuyuki Morino (top) (BE, electrical engineering, Kyoto University, Japan, 1961) is a manager in the nuclear fusion project department in the Nuclear Fusion Project Division of Hitachi, Ltd. He was a leader of the Japan Atomic Energy Research Institute tokamak coordination team for JT-60 and has been involved in the analysis of technology transfer between fusion research and development and other technologies. He is currently interested in the promotion of activities in fusion research and development through Japanese industry. **Taro Iwamoto** (bottom) (ME, mechanical engineering, Waseda University, Japan, 1972)


is a senior researcher in the 2nd department, Mechanical Engineering Research Laboratory, Hitachi, Ltd. He has developed remote maintenance devices such as a remote controlled pipe welder, inspection devices, a mobile robot, and a manipulator. He is currently interested in advanced teleoperation technology for nuclear technology. **Yoshitaka Gotoh** (right) (MS, nuclear engineering, Kyoto University, Japan, 1970) worked at Central Research Laboratory, Hitachi, Ltd., from 1970 to 1985 in research and development of solid surface analysis. In 1979 he became involved in the area of plasma/surface interactions (PSIs). He has worked at Hitachi Research Laboratory in the field of plasma-facing components and PSI studies since 1984.

15. KAWASAKI HEAVY INDUSTRIES, LTD.

Takeshi Kobayashi

Takeshi Kobayashi (no photograph available) (MS, nuclear engineering, Osaka University, Japan, 1969) is manager of the Department of Research and Development, Nuclear Systems Division, Kawasaki Heavy Industries (KHI). He has worked in the nuclear fusion program at KHI, mainly in the field of blanket engineering. From May 1984 to May 1988, he worked on the Fusion Experimental Reactor at the Japan Atomic Energy Research Institute, where he headed the reactor structure group. He also participated in the International Tokamak Reactor (INTOR) group.

OVERVIEW

BIBLIOGRAPHY OF FUSION PRODUCT PHYSICS IN TOKAMAKS

Lee M. Hively
D. J. Sigmar

Lee M. Hively (top) (BS, engineering science, and BS, mathematics, 1970, Pennsylvania State University; MS, physics, 1971, and PhD, nuclear engineering, 1980, University of Illinois) is a research staff member in the Health and Safety Research Division of Oak Ridge National Laboratory (ORNL). He is responsible for large code development and implementation on the Cray computers. From 1971 to 1974, he was a member of the research staff at the Western Electric Company Engineering Research Center and later obtained a U.S. patent as a result of his work on millimetre waveguide. He was a plasma systems physicist with General Electric Company at the Fusion Engineering Design Center at ORNL from 1980 to 1984. Since 1986 he has been on temporary assignment to the Office of Fusion Energy at the Germantown headquarters of the U.S. Department of Energy. His research interests include high-energy fusion product transport and plasma performance in tokamaks. **D. J. Sigmar** specializes in the theory of magnetically confined tokamak plasmas. His publications range from high- and low-frequency microinstabilities to magnetohydrodynamics equilibrium and stability problems to neoclassical impurity transport and alpha-particle dynamics in ignited plasmas. He is adjunct professor of nuclear engineering at the Massachusetts Institute of Technology and a research staff member at its Plasma Fusion Center.

ON COLD FUSION

Bernard I. Spinrad

Bernard I. Spinrad (PhD, Yale University, 1945) spent most of his working career as a nuclear and reactor physicist at Argonne National Laboratory (ANL) and Oak Ridge National Laboratory. He was director of the Reactor Engineering Division at ANL and of the Division of Nuclear Power and Reactors at the International Atomic Energy Agency. He was Northwest energy chair professor at Oregon State and is currently professor and chair of the nuclear engineering department at Iowa State University. His interests include nuclear futures, neutron transport, and nuclear waste.

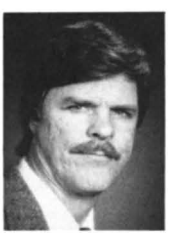
AN ANALYSIS OF COLD AND LUKEWARM FUSION

Mario Rabinowitz
David H. Worledge

Mario Rabinowitz (top) is senior scientist at the Electric Power Research Institute (EPRI). Prior to joining EPRI in 1974, he was at Stanford University at the Linear Accelerator Center for 7 years. Previously, he was a manager at Varian Associates and a senior physicist at the Westinghouse Research Center. He is currently an adjunct professor at the Georgia Institute of Technology. He has taught at Stanford University, San Jose State University, and San Jose City College and was an adjunct professor at Boston University and Case Western University. His interests include superconductivity, physical electronics, electrical discharges, surface physics, and vacuum physics. **David H. Worledge** (BS, physics, 1967, and PhD, experimental nuclear physics, 1970, University of Birmingham, United Kingdom) is a program manager in the Nuclear Power Division at EPRI and the technical director of EPRI's work on cold fusion. His previous work involved managing research to improve the safety and availability of U.S. nuclear power plants. Before joining EPRI he worked at Sandia National Laboratories and Los Alamos National Laboratory and was a research associate at Rutherford Laboratory. He was head of the Systems Reliability Service of the United Kingdom Atomic Energy Authority and also worked in the Nuclear Technology Safety Section.

EXAMINATION OF CATHODICALLY CHARGED PALLADIUM ELECTRODES FOR EXCESS HEAT, NEUTRON EMISSION, OR TRITIUM PRODUCTION

Harold Wiesmann



Harold Wiesmann (BS, 1972, and PhD, 1977, State University of New York–Stony Brook) has worked on the synthesis and evaluation of superconducting A15 compounds and the fabrication and evaluation of high-efficiency amorphous silicon solar cells. Most recently, he has been fabricating and evaluating thin films of the newly discovered high-temperature superconductors.