PREFACE

FUSION REACTOR MATERIALS: 1973 ANS WINTER MEETING

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Many evaluations concerning the status of fuel reserves have been published recently. They conclude, in general, that the fossil-fuel reserves are being depleted rapidly and that the ultimate reserve in nuclear fission awaits the development of efficient breeder reactors. Both sources of energy are being further devaluated by ecological considerations. Geothermal power cannot begin to meet national needs and is restricted in location. Solar energy is a vast reserve but eludes economical utilization. Beyond these fuel resources lies the potential fuel, deuterium, a heavy isotope of hydrogen, present in the oceans. Deuterium is readily recovered from water and provides a vast power resource. The utilization of this resource depends on the development of economical fusion reactors. As a consequence, fusion research and development is being intensified in this country and throughout the world.

The basic nuclear reactions for fusing hydrogen isotopes have been known for some time. The problem resolves itself into (a) finding methods to regulate the energy release, and (b) developing efficient, economical, and practical fusion-reactor devices. Fusion reactions require that the hydrogen isotope fuels (deuterium-tritium or deuterium) be heated to temperatures comparable to that of the sun (50 to 100 million °C). Concurrent high compression of the fuel is also desirable to trigger the reaction more efficiently. Two principal technical approaches have been delineated. The first approach employs large magnetic fields to contain, compress, and heat a plasma of deuterium-tritium fuel. A Tokamak machine using cryogenic magnets is being developed to provide the magnetic fields to control hydrogen isotope plasmas. The other approach is to use high-intensity pulsed lasers to heat and implode fuel pellets.

A series of papers on fusion power plants was presented at the 1972 American Nuclear Society (ANS) Winter Meeting. These papers included an outline of the U.S. Atomic Energy Commission (AEC) fusion-reactor program and a status of its development. Within the past year, the pace of progress in the development of fusion has quickened. Physics experiments on the magnetic confinement approach are proceeding by constructing larger magnetic machines. Laser-driven fusion has emerged as a contender to the magnetic approach. The achievement of controlled fusion is in the near future. As a consequence, it is not too early to look at the technology required to fabricate practical systems and initiate long-term studies. Topmost in the long-term studies is the testing of materials under anticipated reactor conditions. Ideally, it would be desirable to select the most critical material development programs and initiate them concurrently with the final phases of the physics experiments so that the

transition to full-scale reactor-system research and development can be brought on smoothly and efficiently.

The Materials Science and Technology Division and the Technical Group for Nuclear Fusion of the American Nuclear Society cosponsored three special sessions entitled "Fusion Reactor Materials" at the ANS Winter Meeting, November 11-15, 1973. The papers published here were presented at that meeting. The sessions had two objectives: (a) to define the material problems associated with both technical approaches to nuclear fusion, and (b) to present technical discussions on pertinent material questions.

To meet the first objective, two speakers eminently qualified to discuss design requirements were invited. Arthur P. Fraas, of the Oak Ridge National Laboratory (ORNL), discussed material requirements for the magnetically confined fusion reactor. James M. Williams and Thurman Frank, of Los Alamos Scientific Laboratory, presented the material requirements for laser-fusion reactors.

The second objective was accomplished by contributed papers. The subjects of these papers ranged across the spectrum of material questions. Although the response was excellent, there were some important areas of technology omitted. Notably, these were hydrogen effects on materials, thermal and mechanical shock behavior of materials, high strain rate fatigue of construction materials, and radiation damage to laser optics. Perhaps these topics will receive greater attention in future sessions.

To publish the information presented as soon as possible, it was decided to publish the papers presented at the meeting in two issues of *Nuclear Technology*. The papers presented in this issue are the first group.

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EDITOR'S NOTE

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The Editor