PREFACE

CARBON MATERIALS FOR FUSION APPLICATION

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Researchers and administrators have complained about meetings mushrooming at many locations. Is there a need for another workshop? In addition to the traditional international regional symposia on fusion technology in Europe and in the United States, intercontinental topical meetings on plasma/surface interaction, tritium, materials, and recently on nuclear fusion technology have become fashionable. The particular advantage of the latter meetings, as seen by high-level program administrators, is that they are a useful tool for amalgamating researchers of various professional backgrounds into a community working for fusion research.

Local meetings such as the Workshop on Carbon Materials for Fusion Applications do not rely on a minimum number of participants and do not need to last 1 week because of intercontinental travel of attendees. There is room to discuss scientific details as well as to hear the views of experts from neighboring fields. There is no need to limit the geographical distribution of invited speakers. If a subject backed by a powerful lobby does not fit the program, it can be disregarded without penalties. Managers of large programs may stimulate such local conferences free of complex international steering committees, in particular when the results will be published.

On October 2, 1987, the Third Workshop on Carbon Materials on Fusion Applications took place at Kernforschungsanlage Jülich (KFA) in the Federal Republic of Germany (FRG).

The first two workshops were organized by H. Nickel and colleagues who, together with the European carbon industry, contributed significantly to the development of the German gas-cooled high-temperature reactor. The Institute for Plasma Physics of KFA sponsored the third workshop to introduce the 100 participants from industry and research centers to findings and problems in the areas of plasma physics, plasma chemistry, and surface physics that arise when graphite is exposed to a plasma. The afternoon session was devoted to neutron-induced damage in carbon and roundtable discussions on a data base of unexposed graphite, test facilities, and some selected topics on carbon-fiber composites.

The problem of carbon materials in fusion devices can be divided into two categories:

1. scientific, i.e., investigation of carbon interacting with plasma, hydrogen gas, and neutrons as isolated problems
2. engineering, i.e., optimization of plasma performance and of the endurance of the carbon lining, which acts as a heat exchanger between radiation, fuel, and ash from the plasma on the one hand and the cooling loops of the reactor on the other hand, and as a "bumper" during abnormal plasma behavior.

The workshop selected subjects from both categories to bring some latitude to the meeting. L. de Kock [Joint European Torus (JET)] presented papers on the performance of the carbon lining in JET and the Tokamak Experiment for Technology Oriented Research (TEXTOR) and on the impact of the lining on plasma performance, as well as the heavy loads the lining has to bear during disruptions and the damage done to the first wall.

G. Vieiders [Next European Torus (NET)] categorized the requirements of plasma-facing components of the next-generation fusion devices (see also a similar paper in *Fusion Technology*, **14**, 82, 1988). His paper triggered followup activities by a group of participants and during the U.S.-Japan workshop Q86 in Albuquerque, New Mexico, in March 1988. The main result is a new list of requirements balancing the engineers' point of view with that of plasma and surface physicists.

The engineers were given a full description of chemical erosion in the paper by Vietzke and Phillipps (KFA). W. D. Langer (Princeton Plasma Physics Laboratory) presented a paper on the transport of the eroded products as molecules, radicals, and single ions through and within the plasma adjacent to the plasma-facing components. Thermoshock data were presented by Whitley and Croessmann (Sandia National Laboratories) and global plasma erosion by Goebel et al. (University of California–Los Angeles). These data will serve as an engineering data base and as a classification of graphites and carbon-fiber composites to be irradiated by neutrons. Current knowledge on neutron-induced changes in some graphites was summarized by Kelly (United Kingdom Atomic Energy Authority–Springfield).

The prospect of carbon as a long-lasting reactor component without loss of integrity and properties may be out of reach. There are, however, several reasons to continue research on carbon:

1. Carbon shows good compatibility with plasmas, as demonstrated in JET, the Tokamak Fusion Test Reactor, TEXTOR, the Axially Symmetric Divertor Experiment, etc.

2. Carbon appears to be the only reasonable lining for devices like the Compact Ignition Tokamak, NET, and the International Thermonuclear Experimental Reactor.

3. Carbon exhibits outstanding thermoshock behavior, particularly in carbon-fiber composites, and is therefore indispensable as armor during plasma disruptions.

4. Carbon is largely redeposited near the area of erosion. "*In situ*" processes have been developed, i.e., carbonization in the case where a portion of the first wall has to be recoated. Because of these facts, the frequent exchange of large numbers of carbon tiles may become unnecessary.

5. *In situ* heat treatment of materials damaged by neutrons at high temperatures has not yet been fully assessed. There may be some surprises for the temperature range between 1200 and 2000°C. High temperatures are useful in recovering trapped tritium from the lining. These topics were discussed during the Fourth Workshop on Carbon Materials in Fusion Application, October 16, 1988, in Jülich, FRG.

6. Graphite does not become highly radioactive by neutron bombardment.

Substitution of graphite by silicon carbide has been discussed without a clear recommendation.

The contributions in this special section represent an interesting day in fusion technology at KFA, where research in this area began in the early 1970s.