CONF-820545--7

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SURFACE DATA FOR FUSION DEVICES — PROGRESS REPORT ON DATA COMPILATION
AND ASSESSMENT BY THE U.S., JAPANESE, AND IAEA DATA CENTERS

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CONF-820545--7

DE82 015686

^{*}Operated by Union Carbide Corporation for the Office of Fusion Energy,
U.S. Department of Energy, under contract W-7405-eng-26.

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Introduction

In order to model and understand plasma-wall interactions it is necessary to utilize extensive collections of data on individual particle-surface interaction phenomena. The relevant data are often produced by research groups whose primary interests and motivations lie outside the area of plasma physics; consequently, the data are widely distributed in the literature. A number of data center groups have been set up to collect the relevant information from the literature and to present it in a form suitable for direct use in plasma modelling. This paper is a report by three of these groups: the U.S. Data Center at Oak Ridge National Laboratory (ORNL) (D. H. Crandall, Leader), the IAEA Data Center in Vienna (A. Lorenz, Leader), and the Japanese centers at IPP-Nagoya (Y. Itikawa, Leader) and at JAERI (K. Ozawa, Leader).

Data center activity falls into three categories. First, a categorized bibliography gleaned from the published literature must be formed. Second, the data must be extracted and placed in a useful format (with discrepancies resolved and perhaps empirical curve fitting performed) to produce a broad compendium of information. Third, the data sets relevant to fusion problems must be identified in a handbook or computer file that is readily accessible to the user. The data center groups reporting here are broadly active in all three activities and cover all aspects of atomic and molecular physics, including the specific area of particle-surface interactions.

All the data centers operate with a small permanent staff that devotes much of its time to organizational matters, including the actual publication of bibliographies, reports, and handbooks. Each center is supplemented by a larger group of scientists in the position of consultants or task group members. Each larger group includes scientists who are active in the various research areas covered by the data center activities. They are responsible for literature research, data collection, and data assessment on behalf of the data centers.

The purpose of the present paper is to describe the more recent and continuing activities of these data centers. We shall frequently refer to reports issued by these centers. In some cases copies of these reports may still be available and can be obtained by contacting directly the relevant data centers [1-3].

Bibliographies

The ORNL and IAEA Data Centers devote large fractions of their efforts to the initial stages of reference collection. At the ORNL center some 120 journals are searched and relevant references listed under 144 categories (17 in the area of particle-surface reactions) with a note on the reactants and energy range. The ORNL center annually publishes a bibliography containing 2500-3000 references categorized in this manner [4-6]; the most recent bibliography published is for 1980. To provide a rapid dissemination of information the ORNL Data Center publishes a newsletter [7] six times a year that contains a small

number of the most relevant references. The IAEA publishes a bulletin four times yearly that is a rather complete and current bibliography of references relevant to fusion in the field of atomic and molecular data [8]. Some 110 journals are searched, and relevant references are listed under 23 categories (9 in the area of particle-surface interactions). Category, reactants, energy range, and method are indexed, and all information is stored. Computer retrieval is available for index parameters. The ORNL and IAEA Data Centers cooperate by exchanging current bibliographies.

Collection and Assessment of Data

The Japanese Data Centers at IPP-Nagoya and JAERI are largely concerned with the collection and assessment of data. They utilize the ORNL bibliography and INSPEC computerized searches as the primary bibliographic sources. Task groups of specialists are set up for specific subject areas as their reviews are performed. Numerical data are extracted from the literature and stored in a computer. A system (called AMDIS) has been developed to retrieve and display those data on an interactive basis. At present, computerized data bases have been created for electron-ion collisions, sputtering yields of ions from solids, and backscattering coefficients of light ions from solids. An important component of the work is the determination of semi-empirical equations to represent the published information and to guide both

interpolation and extrapolation. A total of 21 reports have been published, all in the IPPJ-AM series covering data compendia and review in various area of atomic and molecular physics (see refc [2] for a complete listing). Two of these are in the area of particle-surface interactions, one in sputtering [9] and the other in particle reflection [10]. A review on desorption is complete and will be published shortly. Reviews are also being made on how sputtering and backscattering depend on incidence and exit angles. Reports are planned for 1982. The area of hydrogen recycling has been discussed in a workshop, and data collection in selected areas will start soon. The JAERI Data Center under Dr. Ozawa has a number of working groups concentrating on materials properties such as damage, impurity implantation, and trapping. Activity in the trapping areas is coordinated with the Nagoya center to prevent overlap; a report is planned for 1982.

Data Handbooks and Compendia

The final step in the data collection process is the production of handbooks, computer files, or reviews. Data collections such as those described in the previous sections must be edited to extract only the information that is both reliable and relevant. Data that are so unreliable as to be potentially misleading must be eliminated. The handbook collections must be restricted to projectiles found in the fusion plasma environment and to surfaces that have potential utility in fusion reactors.

In 1977 the Oak Ridge Data Center published a two-volume handbook on all aspects of atomic and molecular interactions relevant to fusion, including particle-surface interactions [11]. The section on particle-surface interactions was updated in 1979 by a supplementary report [12]. It has recently been decided to revise and update this handbook by sections, a process that will take until mid-1984. One of the first sections to be covered will be particle-surface interactions.

At the IAEA a somewhat different approach has been taken in order to shorten the delay time in making data available. A review of data for a limited group of reactants has been performed and will be published as an article in a journal. The scope of the review has been restricted to C, Al, Cu, Mo, Ti, W, stainless steel, and TiC as wall materials, bombarded only by e^- , H, D, T, He, C, O, and self ions. The subject areas include reflection, trapping, desorption, impurity generation, evaporation, sputtering, chemical reactions, blistering, arcing, and electron emission. Reviews of each area have been performed, and data have been collected and represented algebraically where possible. The material will be published as a regular article in Nuclear Fusion [13].

Conclusions

Besides presenting data in a format useful to plasma modellers, these data collection activities also serve the function of disclosing gaps in the available data base. The IAEA review panel [13] has pointed

out that information on processes of electron ejection and reflection is sparse and is generally unsatisfactory for purposes of modelling sheath effects. The U.S. and Japanese Data Centers recently held a joint workshop [14] where it was concluded that data on trapping and re-emission was in an unsatisfactory state. In this case the parameters used to record the phenomena are closely related to the model adopted to describe the process. Existing handbooks on materials are generally weak in the areas closely related to metallurgical properties.

All three data centers continue to pursue different aspects of the data collection and review process with a close interaction to avoid significant overlap of activities.

References

- [1] Reports produced by the Controlled Fusion Data Center at ORNL may generally be purchased from the National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia 22161, USA, quoting report number and title. Information concerning other activities of the ORNL Data Center can be obtained from Dr. D. H. Crandall, P.O. Box X, Bldg. 6003, Oak Ridge National Laboratory, Oak Ridge, TN 37830, USA.
- [2] Reports produced by the Japanese Data Center may be obtained by contacting Dr. Y. Itikawa, Institute of Plasma Physics, Nagoya University, Nagoya, Japan.
- [3] Reports produced by the IAEA A&M Data Center may be obtained by contacting Dr. A. Lorenz, Nuclear Data Section, International Atomic Energy Agency, Wagramerstrasse 5, P.O. Box 100, A-1400 Vienna, Austria.
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