

# CONTENTS

Preface

Organization

Research Summaries

## Group I: Reactor Materials and Plasma-wall Interactions

I. 1	Fusion reactor materials and plasma-wall interactions . . . . .	1
I. 2	Irradiation behaviour of materials under complex conditions and the modelling of the behaviour . . . . .	2
I. 3	Characterizations of graphite and low Z ceramics as fusion first wall materials and evaluations of stabilities against plasmas . . . . .	4
I. 4	Relation between radiation-induced segregation and corrosion resistance in ferritic steels . . . . .	7
I. 5	Evaluation of radiation damage in ceramics . . . . .	9
I. 6	Defect structures and mechanical properties of materials irradiated by fusion neutrons with RTNS-II . . . . .	11
I. 7	Development of low activity vanadium-base alloys under fusion reactor environment . . .	13
I. 8	Radiation damage of ceramics as fusion reactor materials . . . . .	15
I. 9	Irradiation effects of low activation steels . . . . .	17
I.10	Permeation of tritium through amorphous alloy . . . . .	19
I.11	Physical and chemical processes of ion wall-materials interactions in the low energy range (below 100 eV) . . . . .	21
I.12	Reflection phenomena of particles during hydrogen recycling process . . . . .	23
I.13	Thermal shock and fatigue properties of coated fusion reactor materials . . . . .	25
I.14	Crack extension in fusion reactor first wall components under combined damage of irradiation and creep . . . . .	27
I.15	Crack growth resistance of isotropic polygranular graphite materials . . . . .	29
I.16	Plasma-wall interactions for long burn fusion devices . . . . .	31

## Group II: Environmental and Biological Effects of Tritium

II. 1	Variations of environmental tritium and their interpretation through the analysis . . . . .	33
II. 2	Tritium concentration of different chemical species in the atmosphere in Fukuoka . . . . .	35
II. 3	Behaviour of environmental tritium as studied from the view points of hydrology and meteorology . . . . .	37
II. 4	Tritium content of environmental waters from the Toyama region, Japan . . . . .	39
II. 5	Sampling and measurement of environmental tritium in various forms . . . . .	41
II. 6	New correction method of detection efficiency in low-level tritium measurement by liquid scintillation counter . . . . .	43

II. 7	Ecological behaviours of tritium in the vicinity of nuclear facilities in Japan . . . . .	45
II. 8	Tritium concentrations in environmental samples around Tokai . . . . .	47
II. 9	Tritium content of environmental water in Aichi prefecture . . . . .	49
II.10	Environmental behaviour of tritium around our institution for the use of non-sealed radioisotopes . . . . .	51
II.11	Nuclear debris from chernobyl observed in Osaka . . . . .	53
II.12	Tritiogenic <sup>3</sup> He in ground waters from Tonami plain . . . . .	55
II.13	Environmental Tritium in southwest islands, Japan . . . . .	57
II.14	Diffusion of tritiated water in soil . . . . .	59
II.15	Oxidation of tritium gas in environment –Producing reaction of tritiated water– . . . . .	61
II.16	Internal radiation of normal Japanese with tritium in natural environment . . . . .	63
II.17	Fallout <sup>3</sup> H ingestion in Akita, Japan . . . . .	65
II.18	The transfer of tritium in the environment . . . . .	67
II.19	Biomedical effects of tritiated water . . . . .	69
II.20	Induction of neoplastic transformation and chromosome aberration by tritiated water in golden hamster embryo cells . . . . .	73
II.21	Transformation of Syrian hamster embryo cells exposed to tritiated water . . . . .	75
II.22	Chromosomal responses to low level tritium . . . . .	77
II.23	Development of a cytogenetic monitoring system for human exposure to tritium using peripheral lymphocyte cultures . . . . .	79
II.24	Genetic RBE of tritiated water . . . . .	81
II.25	Induction and repair of DNA breakage induced by tritiated water in cultured mammalian cells . . . . .	83
II.26	Tumorigenicity of tritium water on mice . . . . .	85
II.27	Tritium effects on mouse intestinal cells . . . . .	87
II.28	Mechanism and detection of hemopoietic injury by tritiated water . . . . .	89
II.29	Effect of tritiated water on hematopoietic tissue . . . . .	91
II.30	Effect of tritiated water on the development of the fertilized egg of the mouse . . . . .	93
II.31	Somatic effects of tritium . . . . .	94
II.32	Uptake studies of tritium into body and evaluation of it's biological effects . . . . .	96
II.33	Metabolism of organically bound tritium and a model for the estimation of accumulated dose due to internally deposited tritium . . . . .	98
II.34	Urinary tritium as an indicator of tritium metabolism in the body . . . . .	100
II.35	Tritium content in tissue free water of Japanese body . . . . .	103
II.36	A nationwide tritium concentration survey in TAP water in Japan . . . . .	105
II.37	Dose estimation in rat exposed orally to tritiated thymidine . . . . .	107
II.38	Metabolism and excretion of tritium from tritium gas and tritiated water . . . . .	109
II.39	Oxidation of tritium gas by microbes . . . . .	111

II.40	Dosimetry of tritium simulator . . . . .	113
II.41	Tritium simulator, a low dose rate gamma irradiation apparatus and biological studies of tritium effects . . . . .	115
II.42	Correction factor of absorbed dose of tritiated water for normal human fibroblasts . . . . .	117
II.43	<i>In vivo</i> somatic mutation in mice induced by tritium . . . . .	119
II.44	Specific ability of organ tissues to release tritiated water (HTO) . . . . .	121
II.45	Biological effects of tritium on cultured mammalian cells and small animals . . . . .	123
II.46	Effect of tritiated water on human bone marrow CFU-F and CFU-E colony formation . . . . .	125
II.47	The effect of tritiated water on bone marrow chromosomes of human . . . . .	127
II.48	Effect of tritiated water on germ cells. —A comparison with tritium simulation using mouse newborn oocyte death as index.— . . . . .	129
II.49	The teratogenic effects of tritiated water and tritium simulator on rat embryos . . . . .	131
II.50	Killing effects of tritium water in human thyroid cells and RBE . . . . .	133
II.51	Molecular structure of damage in nucleic acid induced by tritiated water . . . . .	135
II.52	Some factors of DNA damage by tritiated water . . . . .	137
II.53	Low dose rate effect of tritium beta-ray on transforming DNA of M13 mp10 phage . . . . .	139
II.54	Chemical effects of $\beta$ -decay in tritium labelled uracil in oxygenated aqueous solution . . . . .	141

### Group III: Fundamentals of Reactor Plasma Control

III. 1	Fundamental researches on fusion plasma control (coordinating committee) . . . . .	143
III. 2	Development of diagnostic techniques of implosion plasma . . . . .	146
III. 3	Diagnostics on implosion process in an interaction of intense pulsed light-ion beam with target . . . . .	148
III. 4	High accuracy neutron measurement in magnetic confinement system . . . . .	150
III. 5	Atomic processes in laser-imploded plasmas . . . . .	152
III. 6	Physics of spin polarized fusion reactions . . . . .	154
III. 7	Transport and control on RF-heating plasmas . . . . .	157
III. 8	Antennas and transmission systems for high power RF plasma heating . . . . .	159
III. 9	Heating and control of plasma by Alfvén waves . . . . .	161
III.10	Development of Schottky diode detector/mixers for high temperature plasma diagnostics . . . . .	163
III.11	Studies on the optimization of plasma confinement in external conductor systems . . . . .	165
III.12	Mechanism of thermal barrier potential formation . . . . .	170
III.13	Spectroscopic tomography system for measurement of visible radiation profile of plasma . . . . .	172
III.14	Slow formation of field-reversed configuration plasma . . . . .	174

III.15	Computer simulation and plasma modeling . . . . .	176
III.16	Theory of elementary processes related to fusion research . . . . .	178
III.17	Transport theory in fusion plasmas – Development of new theoretical method . . . . .	180

**Group IV: Superconducting Magnets**

IV. 1	Basic aspect of R & D of superconducting magnet technology (The fourth group) . . . . .	183
IV. 2	Evaluation of advanced superconductive magnet materials under fusion conditions . . . . .	185
IV. 3	New method of stabilization for high-current density superconducting magnet . . . . .	187
IV. 4	Development of advanced A15 type superconducting wires for high magnetic field . . . . .	189
IV. 5	Microstructure of A15 type superconductors and its influence on pinning force . . . . .	191
IV. 6	Low temperature neutron irradiation effects on structure and property of superconducting magnet materials . . . . .	193
IV. 7	Mechanical properties of structural materials for superconducting magnets (Developments of standard test methods at cryogenic temperature) . . . . .	195
IV. 8	Electromagnetic properties of Nb <sub>3</sub> Sn superconducting conductors . . . . .	197
IV. 9	Prediction of the quench of superconducting magnets . . . . .	199
IV.10	Pulsed heat transfer in superfluid helium . . . . .	201
IV.11	Monitoring of superconducting magnets using ultrasonic resonance . . . . .	203
IV.12	Stability and A.C. losses of fine Nb <sub>3</sub> Sn multifilamentary superconductors . . . . .	205

**Group V: Fusion Reactor Blanket Engineering**

V. 1	Promotion of fusion reactor blanket engineering . . . . .	207
V. 2	Benchmark experiments on neutron and induced gamma-ray transmission and development of calculational methods . . . . .	209
V. 3	Magneto-hydro-dynamic, thermal and structural studies on liquid metal lithium cooling of fusion reactors . . . . .	211
V. 4	In-situ tritium release from blanket candidate-materials . . . . .	213
V. 5	Hydrogen isotope separation system with permeation through sintered Ni-Al alloy diaphragms . . . . .	215
V. 6	Prediction of long-term creep curves under service condition of nuclear fusion reactor . . . . .	217
V. 7	Sodium mist cooling a hot surface in compact cassette toroid reactor . . . . .	219
V. 8	Thermomechanical behaviour of first wall materials irradiated by laser . . . . .	221
V. 9	Breeding and recovery of tritium from the CTR blanket materials . . . . .	223
V.10	Development of flaw detection and repairing system for a fusion reactor first wall . . . . .	225
V.11	Experimental studies on 14 MeV neutron induced activation through secondary charged particle reaction . . . . .	227

V.12	High temperature rupture strength of first wall materials in fusion reactor (high temperature strength of ceramics coated wall materials) . . . . .	229
V.13	Control of particle size and sintering in lithium double oxides . . . . .	230
V.14	Hydrogen permeabilities of iron-coated niobium and zirconium membranes in liquid lithium . . . . .	232
V.15	DT- and fast neutron capture gamma-ray profile of first wall materials . . . . .	234

**Group VI: Design and Evaluation of Fusion Reactor**

VI. 1	Design and evaluation of fusion reactors (coordinating committee) . . . . .	237
VI. 2	Plasma production and conditioning technology in Heliotron-E, Gamma-10 and Gekko-XII facilities (collaboration with established small groups) . . . . .	239
VI. 3	Evaluation of structural strength of fusion reactor first wall . . . . .	241
VI. 4	Conceptual design of a reverse field pinch fusion power reactor . . . . .	243
VI. 5	Tritium plasma experiment: Plasma driven permeation . . . . .	245
VI. 6	Investigation, analysis and evaluation of fusion safety research . . . . .	247
VI. 7	Influence of traps and repellers on permeation of hydrogen isotopes in aluminium alloys . . . . .	249
IV. 8	Ignition and burn characteristics of advanced-fuel fusion reactors . . . . .	251