

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	Effects of alloying elements on the mechanical property variation by neutron and ion irradiation	3
I. 3	Proton irradiation creep of an austenitic stainless steel	5
I. 4	Alloying effect on the properties of irradiated molybdenum	7
I. 5	In situ measurements of fatigue of SUS 316 under irradiation by protons	9
I. 6	Effects of alloying elements on microstructure and mechanical properties of newly developed ferritic steel	11
I. 7	Effect of alloying elements on high-temperature strength of modified type 316 austenitic stainless steel	13
I. 8	Effects of alloying elements on strength characteristics of irradiated ferritic steel	15
I. 9	Alloying effect on the fundamental process of irradiation creep ...	17
I.10	Materials design for the first wall	19
I.11	Irradiation creep by means of cyclotron	21
I.12	Stereoscopic observation of defect clusters in irradiated titanium monocarbide	23
I.13	Materials performance under pulse composite stress in ICFR	25
I.14	Fundamental research of aluminum alloys as a material for fusion reactor	27
I.15	The effects of alloying elements on the void swelling in heavily irradiated materials	29
I.16	The effects of alloying elements on the void swelling in heavily irradiated materials--Correlation among micro-structures irradiated by electrons and ions	31
I.17	The effects of alloying elements on the void swelling in heavily irradiated materials--Radiation induced segregation and phase change	33
I.18	The effects of alloying elements on the void swelling in heavily irradiated materials--In-situ observation of radiation damage and simulation correlation	35
I.19	Formation of voids and bubbles in the first wall materials for fusion reactor materials	37

I.20	The effects of alloying elements on the void swelling in heavily irradiated materials--Fundamental process in the formation of voids and blisters	40
I.21	The effects of alloying elements on the void swelling in heavily irradiated materials--Defect structures and solute segregation in heavily irradiated materials	42
I.22	The effects of alloying elements on the void swelling in heavily irradiated materials--Radiation damage in steels	44
I.23	The effects of alloying elements on the void swelling in heavily irradiated materials--Stability change of small precipitates under irradiation	46
I.24	The effects of alloying elements on the void swelling in heavily irradiated materials--Microstructural evolution in dual-ion and/or electron irradiated 316 SS with helium injection scheduling	48
I.25	Temperature and dose dependence of swelling in 10% and 20% cold-worked type 316 stainless steels	50
I.26	Study of physical and chemical sputtering processes of low-z compounds and alloys	52
I.27	AES-SIMS-XPS study of physical and chemical sputtering processes of low-z compound materials	54
I.28	ISS investigation of surface phenomena of fusion materials	56
I.29	Physical and chemical properties of low-z compound thin films	
I.30	Molecular processes of the interaction of hydrogen atomic beam with the surface layers of solids	61
I.31	The effect of the plasma-surface interaction on the thermo-nuclear plasma	63
I.32	Kinetic studies of composition change of alloys by physical and chemical sputtering	65
I.33	Hydrogen Absorption, permeation, and recycling of first wall materials	67
I.34	Benchmark experiment for neutron transport through blanket and shield of fusion reactors	69
I.35	Transport of D-T neutrons through polyethylene and water	71
I.36	Transport of D-T neutrons through concrete	73
I.37	Development of response-function evaluation code systems (RECS) ...	75
I.38	Adjustment of response matrix of NE-213 fast neutron spectrometer	77
I.39	Experiment on D-T neutron streaming through cavity geometry	79

I.40	Measurements of fundamental data for secondary emission neutrons from blanket materials on fusion reactor	81
I.41	Photon production nuclear data of fusion reactor materials for fast neutrons	83
I.42	Measurement of neutron double differential cross sections for fusion reactor materials and development of related transport code systems	85
I.43	Neutron dosimetry in neutron irradiation fields	90
I.44	Evaluation of weldability and joining properties on materials for nuclear fusion reactor vessel	92
I.45	Evaluation of weldability for weld zone of high precision joining	94
I.46	In-process measurement in high precision joining process	96
I.47	High precision welding, weldability and cutting	98
I.48	Weldability of molybdenum alloy and SUS 316 stainless steel	100
I.49	Microstructural evaluation of welds under fusion reactor environment	102
I.50	Metallurgical estimation of weldmants as first wall in fusion reactor	104
I.51	Dynamic observation of welded materials by HVEM and their assessment--Phase transformations in NiTi shape memory alloys induced by electron irradiation	107
I.52	Weldability of austenitic alloys	109
I.53	Control of welding stress and strain in structural members and welded joint	111
I.54	Plasma spray coating of low-z ceramics on molybdenum	113
I.55	Development of coating technique for first wall of fusion reactor and its evaluation	115
I.56	Ceramics for fusion reactor applications	117
I.57	Thermal conductivity of CF/FC composite	118
I.58	Bonding mechanism of ceramic coating and its improvements	120
I.59	Strength mechanism of ceramic/metal interfacial bonding	124
I.60	Low-z coating and its characterization (Annealing of TiC-316 SS system)	124
I.61	Evaporation of amorphous Si ₃ N ₄ -C composites prepared by chemical vapor deposition	126
I.62	Joining of ceramics	128
I.63	Joining of dense silicon carbide by aluminum metal	130

Group II : Science, Technology and Biological Effects of Tritium

II. 1	Cooperative works on fundamental studies on tritium technology and biological effects of tritium	133
II. 2	Fundamental studies on tritium technology--Breeding, recovery, and recycling	135
II. 3	Tritium release from neutron-irradiated intermetallic lithium-aluminum	137
II. 4	Tritium-release behavior from irradiated lithium compounds	139
II. 5	Tritium permeation through amorphous metal Pd ₈₀ Si ₂₀ alloys	141
II. 6	Recovery and utilization of tritium gas	143
II. 7	Enrichment of tritium in water by Al-alloys	145
II. 8	Isotope fractionations by high-performance liquid chromatography ..	147
II. 9	Laser isotope separation of deuterium and tritium	149
II.10	Separation and concentration of tritium by the palladium alloy membrane	151
II.11	Equilibrium characteristics on cryo-sorption of H ₂ , D ₂ and He on molecular sieve zeolites	153
II.12	Development of tritium gas handling faculty	155
II.13	Development of tritium concentration data acquisition system for liquid scintillation counter	157
II.14	Detection of tritium by bremsstrahlung and fluorescent X-ray counting	159
II.15	Hydrogen isotope effects at desorption of water from desiccants ...	161
II.16	Monitoring system for fusion reactor and tritium plant	163
II.17	Chemical interaction of tritium with wall substances in helium	165
II.18	Compilation and formulation of standard data of thermodynamic and transport properties of tritium oxide (T ₂ O)	167
II.19	Fundamental studies on tritium technology--Safety handling, permeation control, and waste management	169
II.20	Behaviors of hydrogen & it's isotopes (D, T) in metals containing imperfections	171
II.21	Distribution of tritium in SUS 316 stainless steel	173
II.22	Storage of hydrogen into plasma-deposited silicon: New tritium sealing possibility	175
II.23	Safety confinement of tritium	177
II.24	Estimation on leakage of tritium gas--From high-pressure experiments on H ₂ , D ₂ and He gases	179

II.25	Hydrogen behavior in metals under radiation field and metal corrosion by lithium	181
II.26	Tritium permeation under thermal gradient through Nb first wall ...	183
II.27	Tritium adsorption of reactor materials damaged by heavy-ion irradiation	185
II.28	Permeation, diffusion, and solution of hydrogen isotopes in/through organic materials	187
II.29	Basic study on diffusion and permeation of tritium in the solid phase	189
II.30	Water vapor permeation through rubbers	191
II.31	Development of rubber materials having the excellent barrier property of tritium gas	193
II.32	Safety aspects of tritium waste	195
II.33	Adsorption and desorption of tritium on secondary electron multipliers	197
II.34	Application of channel electron multiplier to tritium containing system	199
II.35	Development of DT fuel fill system for laser fusion target	201
II.36	Studies of biological effects of tritium	203
II.37	Cooperative study on biological effects of tritium beta-rays with respect to man	205
II.38	The system of the treatment of tritiated water in biological experiments	207
II.39	Cytogenotoxicity of tritium: Sister chromatid exchanges induced by tritiated water in mice	209
II.40	Genetic effects of tritium	211
II.41	Microdosimetry of ^3H beta rays--Analysis of survival curves of bacteria in tritiated water	213
II.42	Calculation of cellular microscopic dose distribution from the tritium β -ray	215
II.43	Effects of tritium on the cells and their constituents	217
II.44	Effects of tritium on DNA: Adenine radiolysis	219
II.45	Tritium distribution in environmental ecosystems in the vicinity of certain nuclear facilities	221
II.46	Effects of low-dose irradiation from tritium labelled uridine on the induction of somatic mutations in tradescantia	223
II.47	Somatic effects of tritium	225
II.48	Effects of HTO on yeast cells	227

II.49	Effects of tritiated water on several model biological systems	229
II.50	Effects of tritiated water on survival and mutagenesis cells, and on muse sperm	231
II.51	Development of the monitoring system for human exposure to tritium: Chromosomal aberrations in human G ₀ lymphocytes exposed to HTO	233
II.52	The effect of tritium water on hematopoietic tissue--Preliminary experiments	235
II.53	Hematopoietic disorders by tritium compounds in men	237
II.54	Behavior of environmental tritium	239
II.55	Tritium behavior in food chain	241
II.56	Incorporation of tritium to the food chain	243
II.57	Incorporation of the environmental tritium into the biological compounds	245
II.58	Uptake of tritium into sperms of mice injected with tritium- labelled substances	247

Group III : Fundamentals of Reactor Plasma Control

III. 1	Fundamentals of reactor plasma control	249
III. 2	High temperature plasma diagnostics with far infrared radiations	254
III. 3	Measurement of atomic density near the vacuum wall of high-temperature plasma devices with laser fluorescence spectroscopy	263
III. 4	Development of an injection-locked TEA CO ₂ laser and of a large output power submillimeter laser pumped by the CO ₂ laser	265
III. 5	Optical measurement of high- β plasma with a high temporal- and spatial resolution	267
III. 6	Spectroscopic measurement of the fluctuating field in plasmas with aid of the selective excitation	269
III. 7	Development of a single-optical-axis monochromator in the VUV region for plasma research	271
III. 8	Development of optical and magnetic diagnostic technique for laser fusion	273
III. 9	Extreme ultra violet radiations and charge exchange processes in collisions of multiply-charged ions	275
III.10	In-situ data handling in diagnostics of simulated inertially confined fusion plasma with high speed digitized storage scope on-line connected with computer	277
III.11	Dosimetry of single burst radiations from nuclear fusion plasmas	279
III.12	Spectroscopic study of new laser materials	281
III.12-1	Accurate study of KrF laser kinetics	283
III.12-2	Direct measurement of saturation property of an electron-beam pumped KrF laser	285
III.12-3	Deactivation of excimers by collisions with neutral species	288
III.12-4	Time-resolved spectroscopy of atomic and molecular processes in ionized gases by high intensity pulsed electron beams	290
III.12-5	Development of high power discharge pumped XeCl laser	292
III.12-6	Spectroscopic studies for alkali dimer lasers	294

III.12-7	Xe ₂ Cl triatomic excimer laser characteristics in intense E-beam-pumped Ar-Xe-CCl ₄ mixtures	296
III.12-8	Characteristics of a pulse discharge and dissociations of polyatomic molecules	298
III.12-9	REB-irradiated manganese complex vapor	300
III.12-10	Analysis of optogalvanic effect signal in CO ₂ laser process	301
III.12-11	Fluorescence characteristics of discharge excited KrF* at higher temperature	303
III.12-12	Measurements and non-empirical calculations of rotational relaxation rate constants of some laser molecules	305
III.13	Amplification by HF chemical lasers initiated by an intense-relativistic E-beam	307
III.14	Time resolved spectroscopic study of excited state population in excimer laser	309
III.15	Growth of large size KDP single crystal for high power harmonic generation in laser nuclear fusion	311
III.16	Subsonic multiple jet aerodynamic window	313
III.17	Intense pulsed ion beam driver with cryogenic anode	315
III.18	Research and development of induction accelerator of "medium-mass ion beam" as a new driver	317
III.19	Improvement of deuterated polymer pellet gain for inertial confinement fusion	319
III.20	Pellet coating by plasma chemical vapour deposition	321
III.21	Electrodynamic method of pellet handling	323
III.22	Development of accelerator of intense ion beam by the adiabatic compression of ion ring	325
III.23	Wave heating and control of high temperature plasmas	327
III.24	Development of negative ion sources	332
III.25	Neutralization of ion beams on semiconductive ceramic surface	334
III.26	Nonadiabatic scattering of ion beams due to a periodic magnetic field	336
III.27	Electrostatic energy conversion from charged particles	338
III.28	Theoretical approach to diagnostic methods in fusion plasmas	345

Group IV : Technology of Superconducting Magnet

IV. 1	Basic aspects of R & D of superconducting magnet technology (The fourth group)	349
IV. 2	Processing of superconducting materials by use of a plasma beam melting technique	351
IV. 3	Preparation and neutron irradiation effect of superconducting Mo-based amorphous alloys	353
IV. 4	Production of superconducting materials for nuclear fusion reactors by reaction diffusion method	355
IV. 5	Evaluation of low temperature fracture toughness of structural alloys for superconducting magnet in fusion energy systems	357
IV. 6	Preparation of high T_c superconducting materials	359
IV. 7	The experimental study of pulse shielded superconductive magnetic energy storage	361
IV. 8	Study on magnetomechanical deformation of superconducting magnets in magnetic fusion reactors	363
IV. 9	Electromagnetic properties of multifilamentary composite superconductors under fast ramp-rate magnetic fields	365
IV. 10	High over-all current density and high magnetic field superconducting magnets cooled with pressurized superfluid helium	367
IV. 11	Monitoring and diagnosing technique for superconducting magnets by using acoustic emission technology	369
IV. 12	High critical magnetic field superconductors resistant to radio-activity and stress force	371
IV. 13	Production of superconducting filament by the method of glass-coated melt spinning	373
IV. 14	Reactor irradiation of superconducting magnet materials at cryogenic temperatures	375
IV. 15	Performance study on superconducting magnet materials — Composite Structure —	377
IV. 16	Fracture toughness testing of materials for superconducting magnet	379
IV. 17	Dynamics of nonequilibrium superconducting state induced by high energy radiation	381
IV. 18	Development of a cooling system of superconducting magnets	383
IV. 19	Development of Nb ₃ Sn jelly-roll type superconducting wires by internal diffusion in-situ method	385

IV. 20	Studies on electromagnetic properties of superconducting magnets by using coil simulation measurements	387
IV. 21	Dynamic performance of the pool boiling in liquid helium	389

Group V : Design and Evaluation of Fusion Reactor

V. 1	Conceptual design and assessment of fusion reactors	391
V. 2	System design of fusion reactors	393
V. 3	Conceptual design of moving ring reactor: KARIN-I	395
V. 4	A conceptual design of HIF reactor "HIBLIC".....	397
V. 5	Conceptual design of tandem mirror fusion power reactor	399
V. 6	Fusion-fission hybrid reactor system	401
V. 7	Applicability of advanced fuel fusion	403
V. 8	An assessment of fusion reactor safety (II)	405
V. 9	Pellet gain enhancement research for inertial confinement fusion ..	407
V.10	Atomic and molecular data for nuclear fusion research	409
V.11	Plasma-wall data base for fusion research	411
V.12	Dispersed two-phase flow cooling with liquid film for a high heat flux surface in a fusion reactor	413
V.13	Sodium mist cooling for a hot surface in a fusion reactor	415
V.14	Transient thermal analysis of gas-cooled fusion reactor channels ..	417
V.15	MHD implosion experiment of Nak free surface annular flow	419
V.16	Gas cooling heat transfer coupled with radiation in a duct flow with non-uniform high wall heat flux	421
V.17	Stability of crack in ductile material under dynamic electro-magnetic force	423