

Contents

1. Space, Nuclear and Energy Engineering	1
1-01 Radiation Resistance of InGaP/GaAs Dual-Junction Thin-Film Space Solar Cell	5
1-02 Detection of Photons Induced by a Single Ion Strike	6
1-03 Evaluation of Soft Error Rates in SOI SRAM with a Technology Node of 90 nm Using Oxygen Ion Probe	7
1-04 Feasibility Study on a 90 nm Bulk CMOS Process for Applicability to Space Environments	8
1-05 Heavy-ion Induced Current in SOI p ⁺ n Junction Diode	9
1-06 Study of Ion-Implantation Condition Effects for AlGaN/GaN-Based Light Emitting Device	10
1-07 Total Ionizing Dose Tolerance of SiC Buried Gate Static Induction Transistors up to 10 MGy	11
1-08 Evaluation of Radiation Tolerance of General Electronic Devices	12
1-09 Evaluation of Single Event Effects on Commercial-off-the-Shelf Semiconductors for Space Flight Applications	13
1-10 Mechanisms of Changes of Hole Concentration in Al-doped 6H-SiC by Electron Irradiation and Annealing	14
1-11 Hydrogen Diffusion in a-Si: H Thin Films due to High Temperature Ion Irradiation	15
1-12 NV Centers in Diamond Irradiated with High Energy Nitrogen Ions and 2 MeV Electrons	16
1-13 Alpha-radiolysis of Organic Extractants for Separation of Actinides	17
1-14 A Study on Complete Decomposition of Pyrrolidone Precipitants by γ -Ray Irradiation	18
1-15 Study on Stability of Cs•Sr Solvent Impregnate Resin against Gamma Irradiation	19
1-16 Hydrogen Generation in the System of Water-Adsorbent Containing the Organic Extractant by Gamma-Ray Radiation	20
1-17 Irradiation Effect of Gamma-Rays on Cyanate Ester/Epoxy Resins	21
1-18 Development of Radiation-Resistant Lighting	22
1-19 Development of Radiation Resistant Cable	23
1-20 Development of Penetration Part Processing Industrial Method in Radiation Controlled Area	24
1-21 Alpha-Ray Irradiation Damage on Rubber Applied for Glove Box for Plutonium Powder Treatment	25
1-22 Touch-Down Test of Magnetic Bearing Type Centrifugal Contactor with Irradiated Touch-Down Bearing	26

1-23	Studies on Microstructure and Elemental Distributions of Barrier Materials for Geological Disposal of Radioactive Waste	27
1-24	Behavior of Eu during Culture of <i>Paramecium bursaria</i> with Yeast Cells Sorbing Eu	28
1-25	Effect of Groundwater Radiolysis on the Disposal System of High-level Radioactive Waste	29
1-26	Effect of Temperature Change on Irradiation Hardening of Ferritic and Austenitic Steels during Ion-irradiation	30
1-27	Simulation of Neutron Damage Microstructure in Extra High Purity Fe-25Cr-35Ni Austenitic Stainless Steels	31
1-28	Effects of Radiation Damage and Helium on Swelling and Microstructure of EHP Ni-base Superalloy	32
1-29	Irradiation Hardening in Ion-irradiated Hafnium	33
1-30	Conductometric Analysis of Track Etching in Poly(vinylidene fluoride)	34
1-31	Preparation of Anion-Exchange Membranes for Fuel Cell Applications by γ -ray Pre-Irradiation Grafting	35
1-32	Enhanced Reactivity of Ion-track Grafting for Fuel-cell Electrolyte Membranes	36
1-33	Radiation-Induced Graft Polymerization of Styrene into a Poly(ether ether ketone) Film for Polymer Electrolyte Membranes	37
1-34	Nanoscale Structures of Radiation-Grafted Polymer Electrolyte Membranes Investigated by Dissipative Particle Dynamics Simulation	38
2.	Environmental Conservation and Resource Security	39
2-01	Fibrous Catalyst for Biodiesel Production Synthesized by Radiation-induced Graft Polymerization	41
2-02	Development of Zwitterionic Monolithic Column for Hydrophilic Interaction Liquid Chromatography and its Application to the Separation of Catecholamines and Related Compounds	42
2-03	Decolorization of Secondary Treated Water from Livestock Urine Waste	43
2-04	Modification of Hydroxypropyl Cellulose Hydrogels by Blending Poly(vinyl alcohol)	44
2-05	Effect of Grafting Conditions on Radiation-induced Graft Polymerization	45
2-06	The Recovery of Precious Metals Using Biomass Adsorbents	46
2-07	Surface Modification of Vulcanized Rubber by Radiation Co-grafting	47
2-08	ESR Study on Carboxymethyl Chitosan Radicals in Aqueous Solution	48
2-09	Decomposition of Persistent Pharmaceuticals by Ionizing Radiation	49

3. Biotechnology and Medical Application	51
3-01 Damage Spectrum of DNA Strand Break Termini Induced by $^4\text{He}^{2+}$ Ion Beam Compared with that by ^{60}Co γ -rays	57
3-02 Mutagenic effects of He ion particles in <i>Escherichia coli</i>	58
3-03 Mutational Effect of Gamma-rays and Carbon Ion Beams on <i>Arabidopsis</i> Seedlings	59
3-04 Functional Analysis of Flavonoid Accumulation Genes of <i>Arabidopsis thaliana</i>	60
3-05 Ion Beam Irradiation with Rice Seeds for the Mutation Breeding Project of the Forum for Nuclear Cooperation in Asia (FNCA)	61
3-06 Generation New Ornamental Plant Varieties Using Ion Beams	62
3-07 Development of New Gunma Original Variety of Chrysanthemum by Ion Beam Irradiation	63
3-08 Stability of Flower-colour Mutants of Delphinium ‘Momoka’ After Propagation by Tissue Culture	64
3-09 Red–purple Flower due to Delphinidin 3,5-diglucoside, a Novel Pigment for <i>Cyclamen</i> spp., Generated by Ion-beam Irradiation	65
3-10 Effects of Heavy Ion beam Irradiation in Citrus	66
3-11 Effect of Ion Beam Irradiation for <i>Asclepias</i> Species	67
3-12 Producing New Gene Resources in Chrysanthemum Using Ion-beam Irradiation	68
3-13 Ion Beam Breeding of Sugarcane Cultivar "Ni17"	69
3-14 Production of Soybean Mutants with Pale-Green-Leaf Phenotype by Ion Beam Irradiation	70
3-15 Induction of Fusarium Wilt Resistant by Ion Beam Irradiation in Strawberry (<i>Fragaria</i> \times <i>ananassa</i>) Leaf Explants	71
3-16 Assessment of Irradiation Treatments on a Salt-tolerant <i>Arabidopsis</i> , Zu-0 and <i>Thellungiella</i>	72
3-17 Effects of Ion-beam Irradiation on Germination and Growth of Seedlings of Red Pepper ‘Hirosaki zairai’	73
3-18 Effect of Different LET Radiations on Root Growth of <i>Arabidopsis thaliana</i>	74
3-19 Phenotypic Improvement of <i>Bradyrhizobium japonicum</i> USDA 110 into a High Temperature Tolerant Strain in terms of Ion-beam Microbial Mutation-breeding Technology	75
3-20 Fungicide Tolerant Mutation of Entomopathogenic Fungi Induced by Carbon Ion Beams	76
3-21 Improvement of Endophytic Bacteria Using Ion Beams	77
3-22 FACS-based Screening of Yeast Strain Highly Expressing Cellulase	78
3-23 Molecular Analysis of Carbon Ion Induced Mutations in Yeast <i>Saccharomyces cerevisiae</i> Cells	79

3-24	Lethal Effects of Different LET Radiations in <i>Deinococcus radiodurans</i>	80
3-25	Analysis of Mutation Induced by Ion Beams and Gamma-Rays in Vacuum-dried Conidia of <i>Aspergillus oryzae</i>	81
3-26	Ion Beam Breeding of “Sake Yeast” and Test Brewing	82
3-27	The Effect of γ -Sterilization of Carrier Materials on the Shelf Life of Biofertilizer	83
3-28	Electron Spin Relaxation Behaviors of Radicals Induced in Gamma-irradiated Food	84
3-29	Dose-dependency of Electron Spin Relaxations in Irradiated Fresh Mangoes ...	85
3-30	Target Irradiation of Individual Cells Using Focusing Heavy-Ion Microbeam of JAEA-Takasaki	86
3-31	A Quantitative Study of DNA Double-strand Breaks Induced by Heavy-ion Beams: a Problem on the Conventional DNA-sample Preparation ...	87
3-32	Carbon-ion Microbeam Induces Behavioral Changes in the Salt Chemotaxis Learning of <i>C. elegans</i>	88
3-33	Combination Effect of the Heat Shock Protein Inhibitor, 17-AAG, with Carbon-beam and X-ray Irradiation for Squamous Cell Carcinomas <i>in Vitro</i>	89
3-34	Biological Effects of Carbon Ions on Glioblastoma Cell Lines	90
3-35	Analysis of Molecular Mechanisms for Radiation-induced Bystander Effects Using Heavy Ion Microbeams	91
3-36	Difference in Bystander Lethal Effect in Human Tumor Cell Lines Depending on <i>p53</i> -gene Status Induced by Carbon-ion Microbeams	92
3-37	Heavy-ion Irradiation Induces Autophagy in Irradiated C2C12 Myoblasts and Their Bystander Cells	93
3-38	Analysis of Lethal Effect Mediated by Low Dose Irradiation Induced-Secreted factors in Glioma cells	94
3-39	Ion Beam Irradiation Has Different Influences on the Expression of <i>p53</i> in Cultured Human Retinal Vascular Endothelial Cells Exposed to L-dopa among ^{20}Ne , ^{12}C and ^4He	95
3-40	Irradiation with Carbon Ion Beams Induces Apoptosis, Autophagy, and Cellular Senescence in a Human Glioma-derived Cell Line	96
3-41	Effects of Heavy Ion Irradiation on the Precursor Hemocytes of the Silkworm, <i>Bombyx mori</i>	97
3-42	Expression of Two Gelsolins in Response to Heavy-ions Irradiation and Desiccation in the Sleeping Chironomid <i>Polypedilum vanderplanki</i>	98
3-43	Nuclear Localization of a FOXO Transcriptional Factor DAF-16 in <i>C. elegans</i> , which is Required in a Response to IR Irradiation	99
3-44	Analysis of Bystander Cell Signaling Pathway Activated by Heavy Ion-Microbeam	100
3-45	Carbon Translocation in a Whole Plant Body by Using Positron Emitting Tracer Imaging System (PETIS) and Carbon-11-labeled Carbon Dioxide ($^{11}\text{CO}_2$)	101

3-46	Quantitative Evaluation of Rice Varieties in Cadmium Uptake Activities for Remediation of Cadmium-contaminated Soil	102
3-47	Quantitative Study for Nitrogen Fixation in Intact Soybean Plant from PETIS Imaging	103
3-48	Visualization of ¹⁰⁷ Cd Accumulation in Oilseed Rape Plants Treated with Glutathione	104
3-49	Noninvasive Imaging of Zinc Dynamics in an Intact Plant Using the Positron-emitting Tracer ⁶⁵ Zn	105
3-50	Uniformity Measurement of Newly Installed Camera Heads of Positron-emitting Tracer Imaging System	106
3-51	PET Studies of Neuroendocrine Tumors by Using ⁷⁶ Br- <i>m</i> -Bromobenzylguanidine (⁷⁶ Br-MBBG).....	107
3-52	Imaging and Biodistribution of Her2/Neu Expression in Non-Small Cell Lung Cancer Xenografts with ⁶⁴ Cu-labeled Trastuzumab PET	108
3-53	Production of No-carrier-added Lu-177 for Radioimmunotherapy	109
3-54	Improvement of Spatial Resolution of PIXE-CT at TIARA	110
3-55	The Analysis of Trace Metal in a Slice of Subjected Restraint Stress Mice by In-Air Micro-PIXE	111
3-56	The Optimum Conditions in the Analysis of Boron Micro-Distribution in Tumor Cells Using PIXE and PIGE	112
3-57	Measurement of Strontium Distribution in Carious Enamel and Dentin around a Fluoride-containing Material	113
3-58	Evaluation of Cisplatin Concentration in Response to Tumor Hypoxia in Esophageal Squamous Cell Carcinoma	114
3-59	Improvement of Microcapsules that Release Core Contents via Radiation	115
3-60	Analysis of Asbestos Bodies and Fas or CD163 Expression in Asbestos Lung Tissue by In-Air Micro-PIXE	116
3-61	Preparation of Human Erythrocytes for In-Air Micro-PIXE Analysis	117
3-62	Sensitivity of Micro Beam PIXE System in TIARA for Several Trace Elements	118

4. Advanced Materials, Analysis and Novel Technology 119

4-01	Hydrogen Gasochromism of WO ₃ Films Prepared by Reactive Sputtering	125
4-02	Li Ion Implantation into α -rhombohedral Boron: Carrier Doping for Superconduction	126
4-03	Synthesis of Single-Crystalline and Amorphous SiC Nanotubes by Ion-Irradiation Technique	127
4-04	Polymer Optical Waveguides Fabricated by Using Proton Beam Writing	128
4-05	Synergy Effects in Electron/Ion Irradiation and Alkaline Pretreatment on Hydriding Property of Hydrogen Storage Alloys	129
4-06	Atomistic Study of Irradiation-induced Mass Transport Process	130

4-07	Fabrication of Diluted Magnetic Semiconductor Crystals by Ion-Implantation Technique	131
4-08	Synthesis of Functional Polycarbosilane Nano-fiber by Ion Beam Induced Graft Polymerization	132
4-09	Gas Permeation Characteristics of Silicon Carbide Membrane Prepared by Radiation-curing of Polycarbosilane Film	133
4-10	Investigation of Nano Porous SiC Based Fibers Synthesized by Precursor Method	134
4-11	Control of Radial Size of Polymer Nanowire Formed by Ion Beam Irradiation ..	135
4-12	Nano-crystalline Formation of Metallic Glasses by Ion Implantation	136
4-13	Behavior of N Atoms in Nitriding Processes of Evaporated-Ti Thin Films due to Ion Implantation	137
4-14	The Effects of Displacement Damage and Transmutation Atoms on Microstructure of SiC: The Effects of H Atom on Dimensional Change of SiC	138
4-15	Annealing Behavior of Vacancy-type Defects in Electron-irradiated Si _x Ge _{1-x} Bulk Crystals at Low Temperature	139
4-16	RBS Analysis of Mass-transport Process in Au/Cu Film on Sapphire Treated by Centrifugal Forces	140
4-17	Low Temperature Ion Channeling of Fe ₂ MnSi Film Epitaxially Grown on Ge(111)	141
4-18	Vacancy Generation around an SCC Crack Tip in Stainless Steels Probed by a Positron Microbeam	142
4-19	Radiation-Induced Electrical Degradation in CeO ₂ Ceramics Irradiated with 10 MeV Ni	143
4-20	Incident Energy Dependence of Nuclear Reaction Imaging of Boron Doped in Iron	144
4-21	Study on Cu Precipitation in Energetic Electron Irradiated FeCu Alloy by Means of X-ray Absorption Spectroscopy	145
4-22	Cathodoluminescence of Albite Activated by Alpha-particle Induced Luminescence Centers	146
4-23	Evaluation of Fluorescence Materials for Pulsed-neutron Imaging	147
4-24	Positron Beam Study on Vacancy Defects in GaCrN Grown by Molecular Beam Epitaxy	148
4-25	Evaluation of the ZrC Layer for Coated Fuel Particles Probed by a Positron Microbeam	149
4-26	Surface Structure of Si(111)- $\sqrt{21} \times \sqrt{21}$ -(Ag, Cs) studied by Reflection High-Energy Positron Diffraction	150
4-27	Structure Analysis of K/Si(111)- $\sqrt{3} \times \sqrt{3}$ -B Surface by Reflection High-Energy Positron Diffraction	151
4-28	Radiation-induced H ₂ Production and Reactions of OH Radical in Aqueous Solutions Containing Ceramic Oxides	152

4-29	LET Effect on the Radiation Induced Polymerization of Maleimide	153
4-30	Observation of Heavy Ion Induced Transient Species in Water by Spectroscopic Technique	154
4-31	Stabilization of Measurement System of the Heavy Ion Beam Pulse Radiolysis Using Scintillator	155
4-32	Development of a Head Module for Multi-Head Si/CdTe Compton Camera System	156
4-33	Systematic Measurement of Neutron and Gamma-ray Yields on Thick Targets Bombarded with 18 MeV Protons	157
4-34	Establishment of Neutron Fluence Monitoring Techniques for Quasi-monoenergetic Neutron Calibration Fields of High Energy at TIARA	158
4-35	Measurement of Neutron Fluence in the Comparison between TIARA and CYRIC High Energy Neutron Facilities	159
4-36	Study on High Energy Neutron Dosimetry Using Solid State Track Detector	160
4-37	Evaluation of the Response Characteristics of a Portable Cosmic-ray Neutron Monitor	161
4-38	Dose Measurement for 110 keV Electron Beam	162
4-39	Relationship between Internuclear Distance and Charge State of Constituent Ions Resulting from Foil-induced Dissociation of C_2^+ ions	163
4-40	Simultaneous Measurement of Secondary-electron Emission and Coulomb Explosion Imaging for 250-keV/u C_2^+ Ions Bombarded to Thin Carbon Foils	164
4-41	Analysis of Radiation Damage at a Si Surface Bombarded with a Single 10-, 50- and 400-keV C_{60} Ion	165
4-42	Effect of Au Cluster Ion Irradiation on Magnetic Properties of FeRh Thin Films	166
4-43	Positive Secondary Ion Emission from PMMA upon Energetic C_8 Cluster and Mo Ion Impacts	167
4-44	Secondary Electron Emission from Carbon Induced by MeV/atom Carbon Cluster Bombardment	168
4-45	Ion Induced Luminescence from Sapphire Irradiated with Swift Cluster Ion Beams	169
4-46	Processing of an Upstanding Nano-Wire Array Using Ion-Beam Lithography	170
4-47	Fabrication of Dielectrophoretic Devices Using Poly-dimethylsiloxane Microstructures by Proton Beam Writing	171
4-48	Development of Neutron Optics Devices Using Proton Microbeam	172
4-49	Fast Single-Ion Hit System for Heavy-Ion Microbeam at TIARA Cyclotron (III)	173
4-50	Status Report on Technical Developments of the AVF Cyclotron	174
4-51	Development of Beam Generation and Irradiation Technology for Electrostatic Accelerators	175
4-52	Production of Highly Spin-Polarized Positron Source	176

5. Status of Irradiation Facilities 2009	177
5-01 Safety Measures, Utilization Status and Machine Time Proportion at TIARA Facility	179
5-02 Operation of the AVF Cyclotron	180
5-03 Operation of the Electrostatic Accelerators	181
5-04 Operation of Electron Accelerator and Gamma-ray Irradiation Facilities	182
5-05 Utilization of Electron Accelerator and Gamma-ray Irradiation Facilities	183
5-06 FACILITY USE PROGRAM in Takasaki Advanced Radiation Research Institute	184
5-07 Radiation Control in TIARA	185
5-08 Radioactive Waste Management in TIARA	186
 Appendix	 187
 Appendix 1 List of Publication	 189
Appendix 2 List of Related Patents	210
Appendix 3 List of Related Press-Release and TV Programs	212
Appendix 4 Type of Research Collaboration and Facilities Used for Research	214
Appendix 5 A Typical Example of Abbreviation Name for Organizations in Japan Atomic Energy Agency (JAEA)	216