Comprehensive study on material damage mechanism by experimental and theoretical methods and development of materials for high-energy quantum-beam fields

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【Outline of survey】

The high-energy quantum-beam field indicates a spallation neutron source of the intense proton accelerator facility and an external neutron source of Accelerator-Driven-System (ADS) to convert a long-lived radioactive wastes to shorter nuclides or stable ones. The lifetime of materials in such fields will be shorten by an impact damage due to proton beam pulse and an irradiation damage. It is important to develop the methods that will prolong the lifetime for increasing a reliability of the facility. In the present research, we investigate the mechanism of such material damage and develop both materials which will be strong to damages and a system of remedying influences of impact: We will make material irradiation experiments in various radiation fields, and the simulation experiment together with a microscopic observation, and finally we will clarify the mechanism of radiation damage. We will also investigate the impact damage of the material by using the energy-controlled impacts and measuring fine stress distributions on the material surface by mechano-luminescence, observing both bubble behavior near the liquid-and-solid interface and microstructure of solid, and analyzing the experiments through the computer simulation. The impact-remedy system will be developed based on the work mentioned above. In addition, new materials that are strongly resistant to beam-impact and radiation will be developed by using the nanotech and electro-chemical methods. Theoretically, we will develop the radiation damage evaluation code system based on the multi-scale model treating various processes between nuclear reaction and macroscopic material property change. The model and the model parameter coped in the system will be improved by analyzing the experimental data in order to attain high accuracy of life time prediction on materials under heavy impacts or radiations.

【Expected results】

New materials and the impact remedying system that endure an impact or the radiation damage will be created. They will produce a long-life target of spalltion neutron source facility in such as SNS project of United States and J-PARC project of Japan, and increase the facility reliability as a result. Because the high-energy quantum-beam generates many kinds of secondary particles, the damage mechanism is much more complex, compared with the nuclear reactor. We will be able to construct the comprehensive data-base on material radiation damage, based on the experimental data of the present work and measured in the nuclear plants together with theoretical work. The data-base will be useful for prolonging lifetime of nuclear plants by replacing the materials. Moreover, a new technology for the material development will be created in the present research.

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【Term of project】 FY2007 − 2010	【Budget allocation】 35,100,000 yen (2007 direct cost)

【Homepage address】 None