Base Technology Subjects

Nuclear Technology Research Laboratory

Brief Overview

The Nuclear Technology Research Laboratory aims at positively contributing to the solving/alleviation of energy and global environmental problems by means of developing nuclear technologies, including base technologies to support the operation and maintenance of light water reactors, so that the use of nuclear energy is accepted by society in a positive manner.

Achievements by Research Theme

Nuclear Power Generation Technology

【Objectives】

To enhance improvement of plant capacity factor, high burn-up of fuel, introducing the MOX-fuel, and power up-rating of current light water reactors using basic technologies for risk informed safety analysis, reactor fuel integrity, reactor physics, and thermal hydraulics.

【Principal Results】

・Concentration and distribution of Si-atoms in precipitates, which affect corrosion of fuel cladding in a LWR, were estimated by the 3DAP measurements. Consequently, it was clarified that Si-atoms replace with a part of Fe or Ni-atoms in Zr-FeNi precipitates (Fig. 1) [L10015].

・The Bayesian Update Database for PRA Data Analysis has been developed. This system helps plant personnel to calculate the plant specific failure rates used in specific plant PRA [L10014].

Advanced Nuclear Fuel Cycle

【Objectives】

Basic technology of metal fuels and pyro-repeocessing and elemental technology of aqueous reprocessing are developed and improved for applying to FBR fuel cycle and a next commercial reprocessing plant.

【Principal Results】

・Based on the thermochemical database of actinide alloys developed by CRIEPI, a simplified analytical model was developed to simulate the constituent migration phenomenon that occurs in metal fuel during irradiation.

・Basic properties such as viscosity and electroconductivity of simulated borosilicate glass waste were measured for supporting the basis of vitrification process in Rokkasho Reprocessing Plant.

Reactor Systems Safety

【Objectives】

To contribute to the establishment of a rational safety evaluation method that can evaluate a reasonable safety margin to improve the performance of nuclear power plants by obtaining the validation data for safety analysis codes and developing the analytical models.

【Principal Results】

・New methods were devised to acquire three-dimensional transient velocity and void-fraction profiles and were demonstrated for an air-water two-phase flow in a simulated upper plenum and fuel bundle flow path [L10002, L10003, L10006]

・BWR stability was analyzed with the best estimate analysis code TRACE. TRACE can predict previous test results qualitatively. The correlation of two-phase frictional loss must be improved for more precise prediction [L10005].

Nuclear Power Technology Applications/Innovative System Assessments

【Objectives】

- To contribute to settlements on R&D strategies of future nuclear power systems by assessment on the key technologies of the system.
- To apply innovative technologies obtained from nuclear power R&D to other industrial fields.

【Principal Results】

- To evaluate the feasibility of fusion energy, the tritium fuel cycle model was constructed considering the possibility of no initial tritium fuel loading. That model can propose and assess the start-up operation and control of the reactor core plasma including the commissioning period.
- In order to develop high performance fuel cladding for LWR by in-house Fresh Green surface modification technology, we devised additional co-doping methods with iron and platinum into carbon-doped zirconium dioxide on fuel cladding. Autoclave tests indicated that the devised method prevents corrosion and hydrogen pickup, compared to the conventional methods..

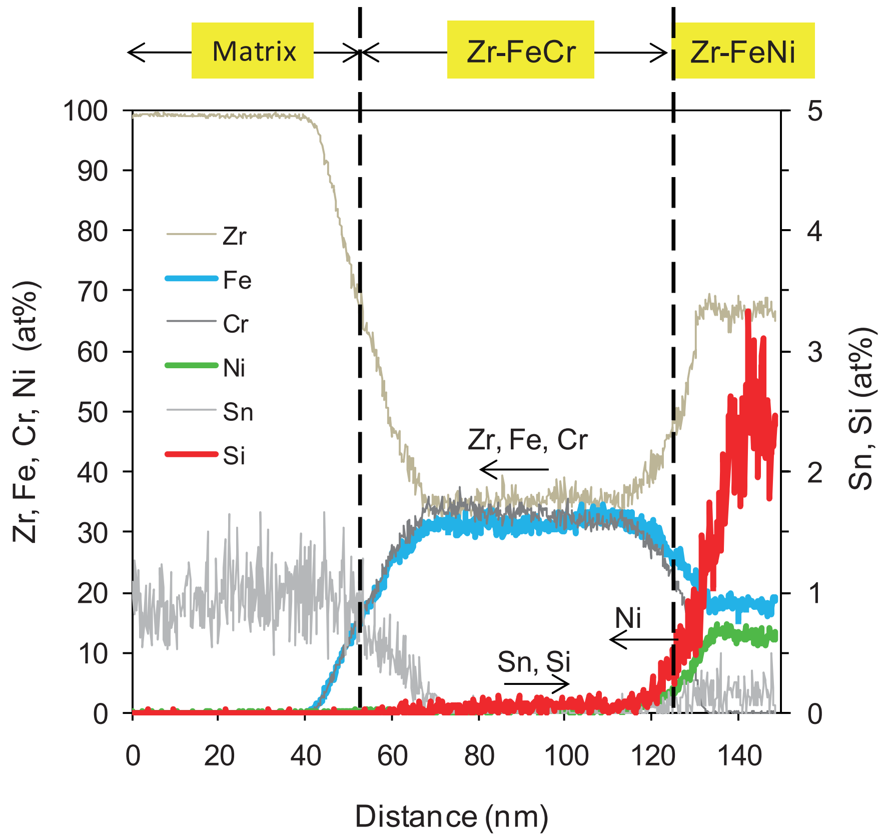

Fig. 1 Chemical composition of metal precipitates in un-irradiated Zircaloy-2 by 3DAP measurement
3DAP is an optimal method to clarify the kind and the position of atoms in a material. Atoms are stripped by local high voltage from the tip surface of a needle sample. This figure indicates the chemical composition of a matrix and two types of precipitates (Zr-FeCr, Zr-FeNi). The concentration of Si increases in the Zr-FeNi type precipitate. By the detailed evaluation of several measurement results, it became clear that Si atoms have been replaced with Fe and Ni atoms in the Zr-FeNi type precipitates.