

# Electric Power Engineering Research Laboratory

#### Brief Overview

The Electric Power Engineering Laboratory is engaged in the advancement of fundamental technologies, including electrical insulation, lightning protection, and high-current technologies for power

transmission and distribution equipment. It is also developing next-generation power equipment and new electric power technologies such as power electronics equipment.

#### Achievements by Research Theme

#### High-voltage and Insulation

We aim to clarify the deterioration mechanism for various aged insulation materials, advance external insulating technology for transmission lines, improve the accuracy of high-voltage measurements, and evaluate and develop insulation materials for next-generation power transmission and distribution equipment.

■ We successfully obtained two dimensional images of rust in coated steel plates by nondestructive measurement using terahertz waves, which are electromagnetic waves in the range between visible

light and microwaves. We also demonstrated that we can measure the thickness of coatings and the rust under the coatings (H11002).

#### Lightning and Electromagnetic Environment

We aim at establishing reasonable measures to deal with lightning damage and develop insulation coordination technology for power systems in the information-communications technology (ICT) society, as well as establishing technology for electromagnetic compatibility (EMC) in power system equipment and consumer equipment.

■ We compiled the Application guide for transmission line surge arresters [H07] and the Guide to the Lightning Protection Design of Power Stations, Substations, and Underground Transmission Lines (Rev. 2011) [H06] through collaboration

with Japanese electric power utilities. Along with the published guides for lightning protection, we established a practical lightning protection design method including related regulations for all electric equipment for power systems.

#### Applied High Energy Physics

We aim to develop simulation methods of pressure rising and propagation characteristics to complement the inner-arc testing of electric power equipment, as well as to develop innovative measurement technologies using laser and optical technologies and to work on their application toward the diagnosis of power delivery apparatuses. We also develop plasma melting technology for reducing the volume of radioactive waste disposal.

■ We developed a simulation method to estimate pressure rise and propagation characteristics due to short-circuit fault arcs in underground common ducts where electric cables are installed (H11034). Using both actual-size short-circuit fault testing and this simulation, we can evaluate pressure rise and propagation characteristics in a wide parameter range. This simulation can be used for improving and evaluating protection methods against disasters.

■ We developed a remote measurement method using laser breakdown spectroscopy to simultaneously

obtain the concentration distributions of several elements that are indicators of degradation caused by the sea salt contamination of concrete structures (H1102) (Fig. 1).

■ The concentration of cobalt is important in evaluating the radioactivity level of the solidified products. We clarified the migration behavior of cobalt in plasma melting treatment of simulated waste including Ni, which will be generated during the dismantling process of nuclear power plants by simulation and experiment.

## Electric Power Application

We aim to develop new technologies related to the next-generation infrastructures of electric power supply and consumption, including power electronics application technologies, such as next-generation electric charging methods for electric vehicles (EVs).

- We proposed a quick AC charging system for EVs using a charger combined with a motor driving inverter system. We designed a 30-kW-class charger and demonstrated the charging performance (H11011).
- We developed a fast algorithm for the Electromagnetic Transient Analysis Program for Power Systems (XTAP). By using this algorithm, the calculation speed of XTAP was increased by a factor of 4.8, compared to the conventional algorithm, in the optimum calculation case (H11009). In addition, we developed a method for the precise measurement of the line constants of short-length

underground cables, which has been difficult to measure at actual sites. We confirmed that the line constants measured by this method were very similar to the values estimated by XTAP (H11006).

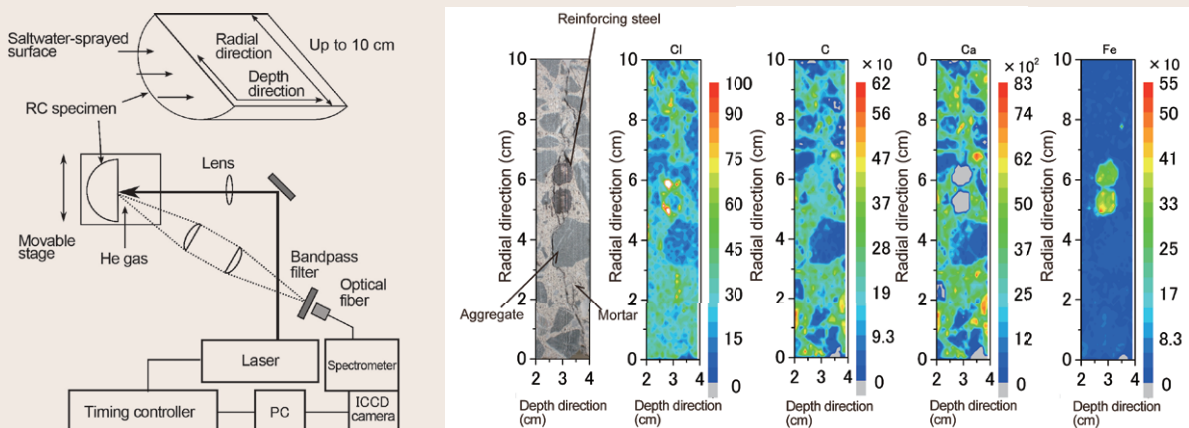
- We proposed a distributed static synchronous compensator as a voltage control method for low-voltage lines when a large number of photovoltaic generation systems and EVs are connected to the distribution line at a specific region in high concentration. We designed a model and demonstrated its performance (H11029). We also proposed a consumer voltage regulation method (H11030).

## High Current Technology

To estimate the performance of electric equipment upon a short-circuit fault, we aim to improve short-circuit test techniques and establish measuring techniques for power frequency currents.

- With collaboration with the Short-circuit Testing Liaison, we operated an international testing project for the cross-calibration of high-current shunts for short-circuit testing.

This time, we compared the standard shunt for Asia and that for Europe, and confirmed good performance in both standards.



(a) Equipment setup

(b) Two-dimensional distribution of the emission intensity of detected elements

**Fig. 1: Laser breakdown spectroscopy of the cut cross-surface of a concrete structure contaminated with salt (The detected elements are Cl, C, Ca, and Fe.)**

The variation of the emission intensity of the chlorine penetrated from the saltwater-sprayed surface (depth: 0 cm) is high around the reinforcing steels, which shows that the corrosion of the reinforcing steel was induced by chlorine; the emission profile was obtained in a short time, at around 40 minutes.