

# Electric Power Engineering Research Laboratory

## Brief Overview

The Electric Power Engineering Research Laboratory is engaged in the advancement of fundamental technologies as the core research institution for power transmission and distribution equipment. It is also developing next generation power equipment and new electric power technologies, such as laser and arc plasma technologies.

## Achievements by Research Theme

### Countermeasures for fault current

#### [Objectives]

To develop a fault current limiting technology and to establish adequate disaster prevention measures for power equipment for the purpose of preventing a public disaster and ensuring a stable power supply at the time of power failure.

#### [Principal Results]

- The characteristics of rising pressure due to fault arc inside power equipment were experimentally clarified including the effects of electrode materials. This knowledge is essential to establish a simulation method for pressure rising.
- The relationship between the critical current properties under magnetic fields and the structures of nano-scaled defects (pinning centers) to stop the movement of quantum magnetic flux which causes the AC loss of YBCO-based high-Tc superconducting wire was clarified. Based on this knowledge, the critical current properties of YBCO-based high-Tc superconducting wires at the liquid nitrogen temperature were improved more than the properties at the liquid He temperature (4,2K) of NbTi which is the metal superconducting wires used practically at present.

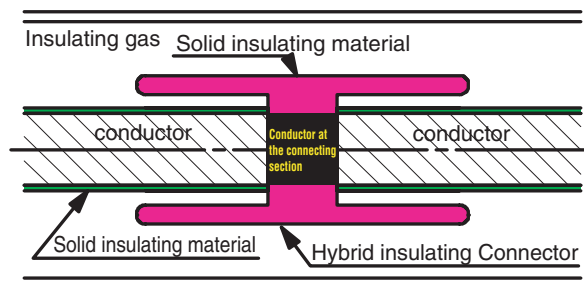
### Electric power apparatus insulation for next generation

#### [Objectives]

To develop next generation insulating technique to realize environmentally friendly and maintenance free electric power equipment which will be required in renewal demand in the near future.

#### [Principal Results]

- A new proposal (Fig. 1) was made for the structure of the conductor of gas/solid hybrid insulation power equipment and the breakdown strength was analysed. Basic characteristics of epoxy resin with aluminium nitride filler, which is proposed as an insulating material for all solid insulating transformer, were obtained. The obtained data, such as dependence of temperature and insulation thickness effect to the AC breakdown strength of this resin are essential to design power equipment.
- Temperature rise test using a real-scale model was carried out to confirm the influence of solar radiation on underground cables buried in a shallow trough, and a reliable method to calculate the cable ampacity for a shallow trough system, which will be adopted in next generation distribution system, was proposed.



**Fig.1** Proposed structure of conductor of gas/solid hybrid insulation power equipment

**Electromagnetic environmental assessment**

**[Objectives]**

To establish a method to assess the electromagnetic phenomena of the emission and conduction of a direct current through the GHz band for ensuring the convenience and reliability of power for both suppliers and users

**[Principal Results]**

- A contact failure at the connecting part of the insulator fitting for a distribution line leads to electromagnetic radiation of up to 2.8 GHz. It was confirmed that electromagnetic radiation of 2.3 GHz or higher generally becomes the background noise level at a distance of some 5 m from the distribution line (Fig. 2).
- The spray forming of tungsten dipped titanium oxide film to either a titanium or stainless steel hollow pipe was shown to be capable of producing a low corona noise spiral cable which has an excellent weathering performance and workability.

**Laser photon science & applications for diagnosis**

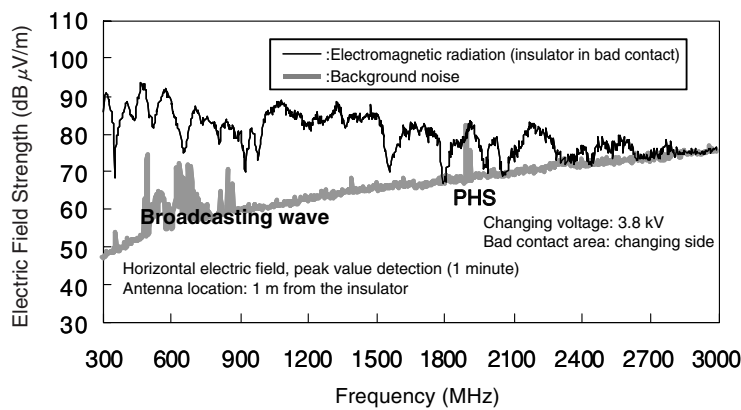
**[Objectives]**

To develop such element technologies as a deep part measurement and diagnosis technology and a laser-induced breakdown spectroscopy (LIBS) technology to ensure accurate equipment diagnosis and understanding of the operating conditions

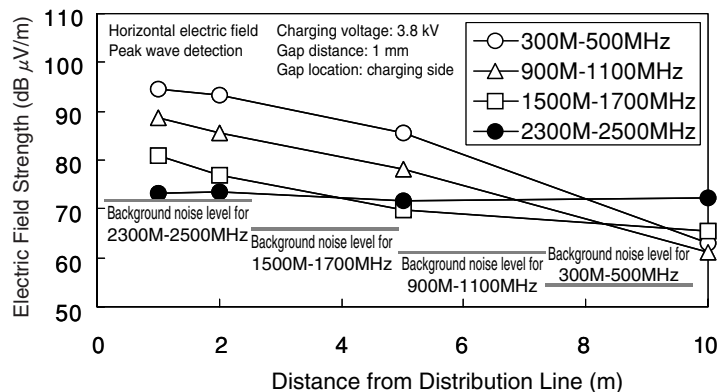
To develop elemental technologies for the measurement and diagnosis of deep inside of materials and laser-induced breakdown spectroscopy (LIBS) to ensure accurate equipment diagnosis and understanding of its operating conditions

**[Principal Results]**

- A compact X-ray source using an ultra-short pulse laser was developed for a radiographic testing(RT) in narrow spaces. Using this X-ray source, a transmission image of a sample made of aluminium 1cm thick was obtained.
- An X-ray imaging system using a small sensor was made. The detection of wall thinning of a pipe with elbow was demonstrated using this system with iridium radiation source.
- From the experimental results using grinded and pressed samples of saline concrete, it was shown that the Cl(chlorine) concentration of 0.6 kg/m<sup>3</sup>, at which the corrosion of reinforcing bars in concrete structure starts, can be detected by LIBS.



(a) Electromagnetic radiation from the insulator in bad contact



(b) Distance characteristics of Electromagnetic Radiation Strength

**Fig.2** Characteristics of Electromagnetic Radiation from Bad Contact Area

