Investigating R&D Committee on Food Sterilization and Processing Technology based on Pulsed Electric Fields

Technical Committee on Electrical Discharges,
Plasma, and Pulsed Power Technologies

1. Objective

Pulsed power technology compresses electromagnetic energy temporally and possibly spatially to obtain large power and high energy density. When the pulsed power is controlled to act on materials, nonroutine energy states, such as nonthermal equilibrium, can be generated relatively easily, together with extremely large power density and energy density. Specifically, these include instantly generated large-intensity electric fields, magnetic fields, electromagnetic waves, heat flux, pressure, plasma, and charged particle beams, which are diverse in application. There has been a remarkably broad application in the biotechnology field in particular, and this technical committee previously established the investigation committee on "Physiological Response and Advanced Application of Pulsed Electromagnetic Energy" and the investigation committee on "Agricultural Water System use of Pulsed Power and Electrical Discharge," which investigated the biotechnology application of pulsed power generating phenomenon and underlying physiological response in the medical, environment, agriculture, and fishery industries. Thus, a widening trend and increasing demand toward applying physiological response of pulsed power for consumers, including sterilization, food processing, and preservation, has been observed. The objective of this investigation committee is to investigate, systematize, and explore the future development of cutting-edge research on the application of pulsed power to food sterilization, processing, and preservation industries.

2. Background and internal and external research activities

The application of pulsed power to sterilization was first reported in the 1960s using pulsed high electric fields in the sterilization of liquids to break down and perforate cell membranes of bacteria. In the biotechnology field, the electroporation technology, which perforates cell membranes with pulsed electric fields based on a similar theory, was established in the 1980s for use in gene introduction and cell fusion. Since the establishment of pulsed power control technology in the 1990s, research into its application for sterilization has rapidly spread, and a summary report was published (Non-thermal Process Dictionary for Biological and Environmental Industries; Mutsuo Iwamoto, et al., Science Forum, 1997). Currently, a considerable amount of patent information on sterilization based on pulsed electric fields has been disclosed. There have been dramatic advancements in research on the application of pulsed power sterilization in the food industry, resulting from the now-relative ease of pulse high-voltage control using semiconductor devices. In addition, food companies are striving to differentiate their products from competitors by adding value, and there has been a sharp increase in demand for non-thermal sterilization technology, with focus on pulsed electric field sterilization. In addition, speeding up food process and extracting useful components through pulsed electric field perforation are being considered. Thus, electric field applications using pulsed power have become a widespread new technology in the food industry. This investigation committee shall compile information on such cases systematically investigate and evaluate he present state and prospects of pulsed electric field applications in the food industry, as well as the pulsed power sources required for applications, and, then, review the present state of technology and look out for trends in future applications.

3. Investigative matters

(1) Summarize applications of pulsed power in the food industry
- Problems with food sterilization
- Interaction of electric fields and cells
- Sterilization and cell manipulation

(2) Use of pulsed electric fields for food sterilization
- Sterilization of liquid foods
- Sterilization of highly conductive fluids
- Sterilization of solid foods
- Sterilization of packaged foods
- Extended storage and shelf life

(3) Use of pulsed electric fields for food processing
- Extraction of useful components
- Deactivation of unwanted components
- Injection of useful components

(4) Equipment development
- High voltage source
- Pulse power supply
- Sterilization systems

4. Expected effects

Each committee member shall investigate research trends in fields close to each application and, thus, systematize the fields researched, while simultaneously sharing information on the sterilization action of pulsed electric fields and their application via regular meetings. Thus, it will be possible to gain a clear perspective on the direction of future research.

5. Term of investigation

January 2019 to December 2021 (3 years)

6. Committee members

Position	Name	Affiliation	Member/Non-member category of IEEJ
Chairperson	Yasushi Minamitani	Yamagata University	Member
Member	Takahisa Ueno	National Institute of Technology, Oita College	Member
〃	Satoshi Uchida	Tokyo Metropolitan University	Member
〃	Douyan Wang	Kumamoto University	Member
〃	Sunao Katsuki	Kumamoto University	Member
〃	Taiga Kajiwara	Kewpie Corporation	Non-member
〃	Katsuyuki Takahashi	Iwate University	Member
〃	Takayuki Oshima	Gunma University	Non-member
〃	Akira Nakano	Ichimasa Kamaboko Co., Ltd.	Non-member
〃	Michihiko Nakano	Kyushu University	Member
〃	Hideki Fukata	JPD Co., Ltd.	Non-member
〃	Yuichi Murakami	Meijo University	Member
〃	Akira Tokuchi	Pulsed Power Japan Laboratory, Ltd.	Member
〃	Kazuo Shimizu	Shizuoka University	Member
〃	Shin Yabukami	Tohoku University	Member
Secretary	Taichi Sugai	Nagaoka University of Technology	Member
Assistant secretary	Takamasa Okumura	National Institute of Technology, Ichinoseki College	Member

7. Activity schedule

Committee meetings: 3 times/year; Secretariat: once a year; Visit once a year

8. Reporting format

A technical report shall be prepared to present the results.