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論　文　内　容　の　要　旨
Abstract of Dissertation

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Pulsed power technology began a hundred years ago and was initially applied in the field of defense technology due to its characteristics of short duration and high power output. With the development of solid-state switch technology in recent years, compact, high repetition rate, and flexible switches have been used in the field of pulsed power to achieve miniaturization of pulsed power generators, which greatly promotes the application of pulsed power technology in industry. However, when pulsed power is applied in industry, especially in the generation of plasma by pulsed atmospheric pressure gas discharge, scientists have also discovered a series of new scientific problems, such as large-area and uniform discharge, time-varying impedance, and memory effect. However, the pulse parameters of pulsed power have significant importance in studying these problems. Therefore, the main purpose of this article is to develop a new type of flexible and controllable solid-state pulsed power generator to study and solve the problems of pulsed atmospheric pressure gas discharge.

This article can be divided into several parts:

Chapter 1: We introduced the background and development trends of pulsed power technology, as well as its typical industrial applications such as tumor ablation, industrial waste gas and water treatment. Finally, we discussed the new scientific problems arising from the application of pulsed power technology in industry, such as the problem of large-area uniform discharge, time-varying impedance in pulsed atmospheric pressure gas discharge, and the memory effect in pulsed atmospheric pressure gas discharge.

Chapter 2: We developed a compact solid-state linear transformer drivers (SSLTD) power generator based on the principle of large-scale LTD, and analyzed the advantages of SSLTD over other traditional pulsed power generators. Combined with some flexible control hardware, we achieved flexible output of SSLTD. Based on this, in order to meet industrial needs, we further proposed the future development trends of SSLTD: automatic feedback control-based SSLTD and bipolar SSLTD.

Chapter 3: In response to the time-varying impedance problem of pulsed power in atmospheric pressure gas discharge mentioned in Chapter 1, we used the SSLTD based on automatic feedback control principle developed in Chapter 2 and implemented control of time-varying impedance in pulse atmospheric pressure gas discharge through appropriate preset programs. As a result, during repetitive operation, our SSLTD can figure out the right output waveform according to a user scenario and can respond to any variation that may occur on the load. The impedance was controlled within a relatively constant range in 100 ns.

Chapter 4: In response to the memory effect problem in unipolar pulsed atmospheric pressure gas discharge raised in Chapter 1, we developed a bipolar SSLTD based on the unipolar SSLTD introduced in Chapter 2. Taking advantage of the output flexibility of the bipolar SSLTD, we have studied the residual charges phenomenon by the coaxial discharge load. The experiment result shows that for two consecutive positive pulses discharge, the current of the second positive pulse is usually lower than that of the first pulse for the same voltage amplitude. However, a middle negative pulse applied between the first and second pulse can increase the current of the second positive pulse. An explanation for this phenomenon has been explored using a 1-D model that considers the effect of residual charge left by the previous pulse discharge. According to the explanation of our 1-D discharge model, this phenomenon may be caused by the residual charge distorting the discharge electric field strength. The findings obtained by this paper will help us understand the fundamental characteristics of pulsed atmospheric pressure gas discharge.

Chapter 5: We summarize the main research content of this article.

Chapter 6: We summarized the achievements obtained during my doctoral period.