Solid-State modulators for Plasma Based Ion Implantation (Invited talk)

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Abstract

Recent pulsed power modulators based on state-of-the-art topologies, using power semiconductors, such as MOSFETs (Metal Oxide Semiconductor Field Effect Transistors) and IGBTs (Isolated Gate Bipolar Transistors), capable of handling the characteristics of Plasma Based Ion Implantation, PBII, technique will be presented and discussed considering the requirements for industrial implantations.
In fact, PBII offers one of the most challenging operating conditions to pulsed power modulators, where a target is immersed in plasma, produced in a confined volume, and almost rectangular negative high-voltage pulses are applied to it. Considering the plasma characteristics and typical desirable output results for PBII, the most important modulator requirements are: (a) voltage pulse waveform independent of the load impedance, which demands a high current peak at the beginning of the pulse, rapidly decreasing to a much smaller value; (b) pulse rise time less than one microsecond and small compared with the pulse width, for obtaining mono-energetic ion implantations, desired for example in microelectronics processing; (c) constant pulse voltage is required in order to reduce the sputtering effect during implantation; (d) pulse duty cycle of a few percent; (e) adjustable pulse width and frequency independently; (f) current limit in case of short circuit; (g) load short-circuiting after the pulse, quickly discharging all the load and parasitic capacitances to zero; (h) compact system including the necessary protection systems for personnel and equipments.

The technological progress of power semiconductors over the last two decades enable today the assembling of compact, flexible, efficient and cost effective modulators, which are devoted to high-repetition rate pulse operation (i.e. industrial applications as PBII). However, the still voltage and current limitations of semiconductors require special techniques that maximize semiconductor benefits minimizing theirs limitations.
The solutions encounter by several authors, from the use of pulse transformers up to the Marx and adder type topologies, passing through the circuits brought from power electronics, for the requirements of PBII will be presented and discussed, considering the application of the circuits in the industry.

Keywords: Solid, state modulators, semiconductor topologies, industrial requirements.

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