

Development of Pulsed Power Generator for EUV source

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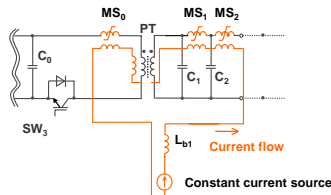
Introduction

In recent years, an extreme ultraviolet (EUV) at 13.5 nm is attracting great attention to the source using for the next generation semiconductor lithography. In order to obtain the EUV emission, laser produced plasma (LPP) and discharge produced plasma (DPP) were progressed. In DPP, a plasma is generated by a high-current pinch of pulsed discharge. For the pulsed power generator, high-current capability and short rise-time are required. Therefore, we designed and constructed a pulsed power generator.

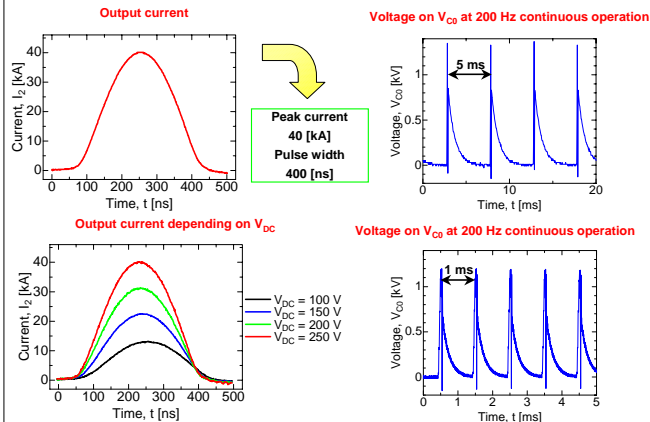
Rating of the generator

Output peak current	> 30 kA
Pulse width	< 600 ns
Repetition rate	200 Hz : continuous 1 kHz : burst mode

Reset circuit for magnetic cores



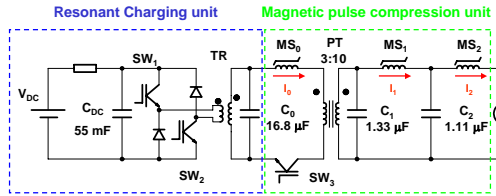
Operation results on shorted load



Conclusion

1. A pulsed high current generator consists of a semiconductor switch and a magnetic pulse compression (MPC) unit for EUV source development has been designed and constructed.
2. Output current to a shorted load has peak value of 40 [kA] and pulse width of 400 [ns].
3. The generator can operate at 200 [Hz] continuously, and 1 [kHz] in burst mode.

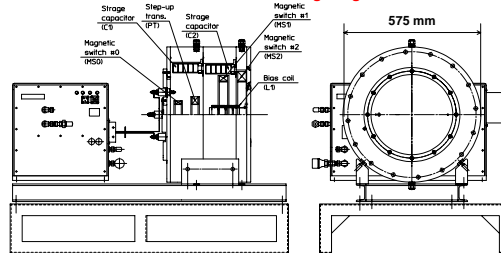
A schematic diagram of the generator



Circuit parameters and values of peak current

Transmission line	Transmission time, μs	Current peak, kA	Inductance, nH
C ₀ to C ₁ (I ₀)	4.4	2.6 (2nd)	2580 (2nd)
C ₁ to C ₂ (I ₁)	1.0	9.4	160
C ₂ to Load (I ₂)	0.55	30	28

Cross-sectional view of designed generator



The generator consists of two units. The one is a resonant charging unit which is used to charge C₀ and the other is a magnetic pulse compression unit which compresses the pulsed output of C₀.

Resonant charging unit

C₀ is charged by DC power supply V_{DC}. After charging is completed, SW₁ and SW₂ are triggered simultaneously. The discharge current flows via C₀-SW₁-TR-SW₂ and C₀ is charged by resonant current flowing in the secondary winding of the transformer TR. The switches (SW₁ and SW₂) are connected in series, so the switching voltage is only half of the operating voltage.

Magnetic pulse compression unit

The magnetic pulse compression unit operates as follows. When C₀ charging is completed, SW₃ is triggered and the voltage is applied on MS₁. MS₁ is used to decrease a switching loss in SW₃ and it saturates in a very short time. The voltage is then multiplied by PT and is applied on C₁. Afterwards, the short pulse compressed by MS₁ and MS₂ is delivered to the load.

Picture of generator



Future plan

Generation of EUV source by dense plasma focus (DPF).

