High Power HVM LPP-EUV Source with Long Collector Mirror Lifetime
(Keynote Presentation)

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We have been developing CO_2-Sn-LPP EUV light source which is the most promising solution as the 13.5nm high power light source for HVM EUVL. Unique and original technologies such as; combination of pulsed CO_2 laser and Sn droplets, dual wavelength laser pulses shooting and mitigation with magnetic field have been developed in Gigaphoton Inc. The theoretical and experimental data have clearly showed the advantage of our proposed strategy. Based on these data we are developing first practical source for HVM; "GL200E". This data means 250W EUV power will be able to realize around 20kW level pulsed CO2 laser. We have reported engineering data from our resent test such around 43W average clean power, CE=2.0%, with 100kHz operation and other data [1)]. We have already finished preparation of higher average power CO2 laser more than 20kW at output power cooperate with Mitsubishi electric cooperation[2)]. We achieved 132W with 100kHz, 50% duty cycle operation during 120 hour[3)]. Recently we have demonstrated short term operation at 264 W level open loop operation at proto type #2 system[4)].

We are now operating new high power HVM LPP-EUV source with new CO2 driver laser system made by Mitsubishi Electric. Now we are demonstrating long collector mirror lifetime (< 0.5% down / G・Pulses) protected by our magnetic mitigation system around 100W level (in burst) operation condition.

1) Hakaru Mizoguchi, et. al.: "Sub-hundred Watt operation demonstration of HVM LPP-EUV source", Proc. SPIE 9048, (2014) [9048-12]
2) Yoichi Tanino et.al.:" A Driver CO2 Laser Using Transverse-flow CO2 Laser Amplifiers" (EUV Symposium 2013, Oct.6-10.2013, Toyama)
3) Hakaru Mizoguchi et al.:" Performance of new high-power HVM LPP-EUV source " Proc. SPIE. 9776, Extreme Ultraviolet (EUV) Lithography VII, (March 18, 2016)
4) Hakaru Mizoguchi, et al: "Development of 250W EUV Light Source for HVM Lithography",EUVL Workshop 2016,(Berkley, 13-16, June, 2016)

Presenting Author

Hakaru Mizoguchi is Executive Vice President and CTO Of Gigaphoton Inc. He is a member of The International Society of Optical Engineering, The Laser Society of Japan and The Japan Society of Applied Physics. He received a diplomat degree in plasma diagnostics field from the Kyushu university, Fukuoka, Japan in 1982 and join Komatsu Ltd. He joined CO2 laser development program in Komatsu for 6 years. After that he was guest scientist of Max-Plank Institute Bio-Physikalish-Chemie in Goettingen in Germany 2 years, from 1988 to 1990. Since 1990 he concentrated on KrF, ArF excimer laser and F2 laser research and development for lithography application. He was general manager of research division in Komatsu Ltd. until 1999. He got Dr. degree in high power excimer laser field from Kyushu university in 1994. In 2000 Gigaphoton Inc. was founded. He was one of the founders of Gigaphoton Inc.. From 2002 to 2010 he organized EUV research group in EUVA program. Now he is promoting EUV light source product development with his present position.