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**Andreas Erdmann**  
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H. Fukuda, Y. Yoo, Y. Minegishi, N. Hisanaga, T. Enami, Gigaphoton Inc. (Japan)
- 9052 2K **Flexible power 90W to 120W ArF immersion light source for future semiconductor lithography** [9052-51]  
R. Burdt, T. Duffey, J. Thornes, T. Bibby, R. Rokitski, E. Mason, J. Melchior, T. Aggarwal, D. Haran, J. Wang, G. Rechtsteiner, M. Haviland, D. Brown, Cymer, an ASML company (United States)

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