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Shields et al.

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[54] **LASER GENERATED X-RAY SOURCE**

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[57] **ABSTRACT**

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An improved high average power, high brightness laser system. The laser system comprises an XeCl excimer amplifier, an XeCl excimer preamplifier, a means for generating a picosecond seed pulse tailored for the XeCl preamplifier and the XeCl amplifier and a means for focusing the output pulse laser beam onto a spot smaller in area than 100×10^{-6} cm². We first produce a seed laser beam consisting of a series of bunches of short duration pulses with a bunch frequency in excess of 100 pulses per second. These seed laser pulses are produced by a Nd:YAG pumped dye laser oscillator with a cavity dumper. The pulses in the beam are preamplified in a multipass preamplifier and the pulses are then multiplexed in a pulse train generator into a larger number of lower power pulses. A multi-pass laser amplifier then amplifies each pulse in the bunched pulse laser beam to produce an amplified pulse laser beam which is then tightly focused to so that the individual pulses are at brightness levels in excess of 10^{11} Watts/cm². A prototype device built and tested by Applicants and their fellow workers has produced a pulsed laser beam with 50 ps, 30×10^{-3} Joule pulses at 1,120 pulses per second to provide a beam with average power of 34 Watts. Focusing the beam at a 10 micron diameter spot produces intensity levels of 7×10^{14} per cm². Using an iron target Applicants have produced X-ray sources of average X-ray power levels in excess of 3.5 Watts. This source is capable of printing integrated circuits with dimensions in the range of 0.1 micron to 0.25 micron at rates of about 10 wafers per hour.

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[22] Filed: **May 4, 1995**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 295,283, Aug. 24, 1994, and a continuation-in-part of Ser. No. 339,755, Nov. 15, 1994, Pat. No. 5,491,707.

[51] Int. Cl.⁶ **H01S 3/22**

[52] U.S. Cl. **372/57; 372/39; 372/10; 372/18; 372/25; 372/22; 372/70; 372/28**

[58] Field of Search **372/57, 53, 39, 372/10, 98, 18, 25, 22, 95, 69, 70**

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11 Claims, 5 Drawing Sheets

