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Semiconductor Production Equipment | Japan

Selection of Octuple Patterning for Node Shrinkage and Potential Impact on the Japanese SPE Industry

We think that SMIC may attain 3-4nm processes in 2025. Exports of EUV lithography equipment to China are prohibited, and node shrinking tech available at present includes octuple patterning. If octuple patterning is adopted, we think this would boost demand for cleaning, etching, ALD, and deposition equipment.

Key Takeaways

- Think SMIC, China's largest foundry, could attain domestic production of 3-4nm GPUs in 2025.
- Currently, quadruple patterning used on advanced lines down to 5nm node; octuple patterning could go to 3nm.
- Problem with octuple patterning is low patterning freedom for a big increase in equipment volume, clean room area, and time required, resulting in lower yields.
- If octuple patterning is adopted, we think this would increase demand for etching, cleaning, ALD, and deposition equipment.
- Japan SPE names that would likely benefit are Tokyo Electron, Screen Holdings, and Kokusai Electric.

China taking on 3-4nm nodes: We believe SMIC's (covered by Charlie Chan) fab could start domestic production of 3-4nm GPUs in 2025 ([Asia Technology: AI supply chain: Introducing Our Pre-2026 CoWoS Forecast \(April 7, 2025\)](#)). China's semiconductor industry cannot import EUV lithography systems, so uses multiple patterning as a means of achieving process node shrinkage. At present, the most advanced semiconductor production processes use quadruple patterning, which enables feature patterning down to the 5nm node even without the use of EUV lithography. Quadruple patterning performs self-aligned spacer processing twice, enabling patterning at one quarter the line-and-space (L/S) pitch of conventional ArF immersion lithography. The method therefore performs exposure twice, not four times.

The potential of octuple patterning: Under octuple patterning, the spacer process is repeated three times, enabling patterning at one eighth the L/S of conventional lithography.

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SEMICONDUCTOR PRODUCTION EQUIPMENT

Japan

Industry View

Attractive

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Tokyo Electron presented the technology at academic conferences and open seminars in the 2010s, pointing out the possibility of 3nm patterning without using EUV lithography systems. From discussion with our contact at Tokyo Electron, we understand that various challenges mean the technology will not be easy to adopt for mass production.

The problems with octuple patterning: The issues with octuple patterning are the inability to use diagonal exposure, which means low pattern density relative to EUV lithography, and the steep increase in the number of processes. This results in a steep rise in both clean room space and processing time, weighing on yields.

Names positioned to benefit from octuple patterning: Were octuple patterning to be adopted, we would anticipate a huge rise in demand for certain SPE. In our estimates, etching and cleansing processes are carried out eight times under quadruple patterning compared to 11 times under octuple patterning, while the frequency of ALD for sidewall formation increases from two to three times, and non-ALD deposition processes for forming multiple layers prior to lithographic exposure rises from five to six times. Commercialization of the technology would present business opportunities for Tokyo Electron, Screen HD, and Kokusai Electric.

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Overweight/Buy	1516	40%	387	46%	26%	694	40%
Equal-weight/Hold	1682	44%	380	45%	23%	805	47%
Not-Rated/Hold	3	0%	0	0%	0%	0	0%
Underweight/Sell	598	16%	81	10%	14%	227	13%
Total	3,799		848			1726	

Data include common stock and ADRs currently assigned ratings. Investment Banking Clients are companies from whom Morgan Stanley received investment banking compensation in the last 12 months. Due to rounding off of decimals, the percentages provided in the "% of total" column may not add up to exactly 100 percent.

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DISCO (6146.T)	O (07/07/2023)	¥26,590
KOKUSAI ELECTRIC (6525.T)	E (04/11/2024)	¥1,848
Lasertec (6920.T)	E (03/05/2024)	¥11,460
Nikon (7731.T)	U (08/08/2023)	¥1,335
SCREEN Holdings (7735.T)	O (02/25/2025)	¥8,770
Tokyo Electron (8035.T)	E (02/25/2025)	¥18,550
Ulvac (6728.T)	E (01/17/2024)	¥4,279
Ushio (6925.T)	E (01/17/2024)	¥1,659

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