

(Supplemental)

Oxide film ALD using OH radicals generated by mixing pure ozone gas with hydrogen-included molecular gas over 200°C.

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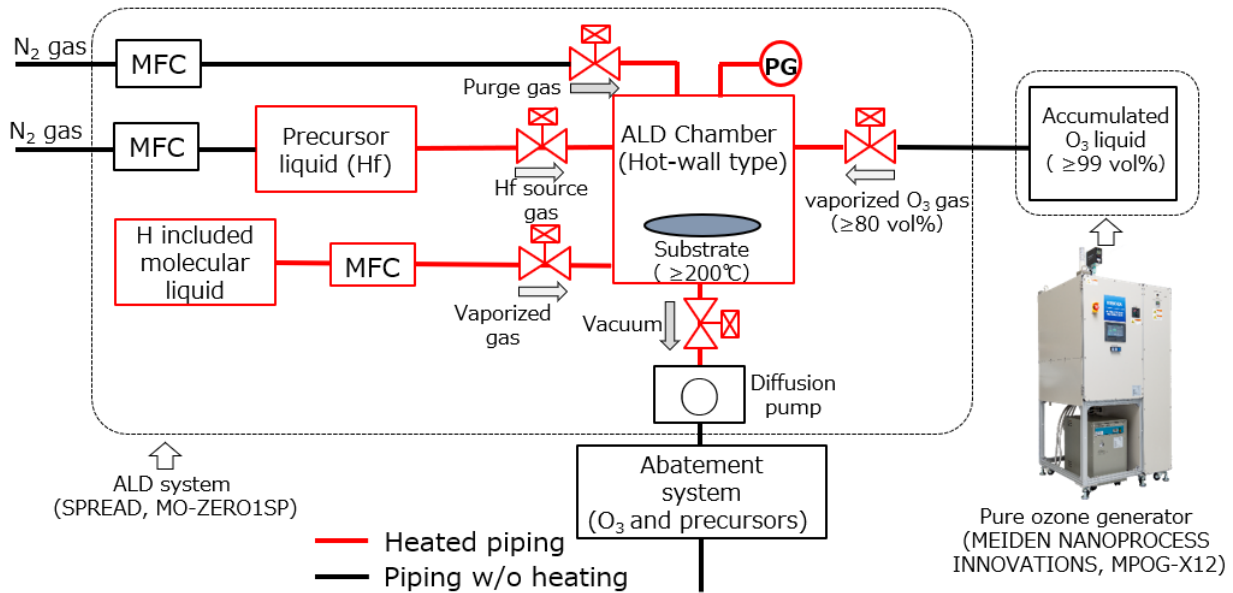


Fig. 1 Schematic images of pure ozone gas with hydrogen-included molecular gas ALD system for the HfO₂ film deposition. Pure ozone and hydrogen-included molecular gas are mixed in the ALD chamber.

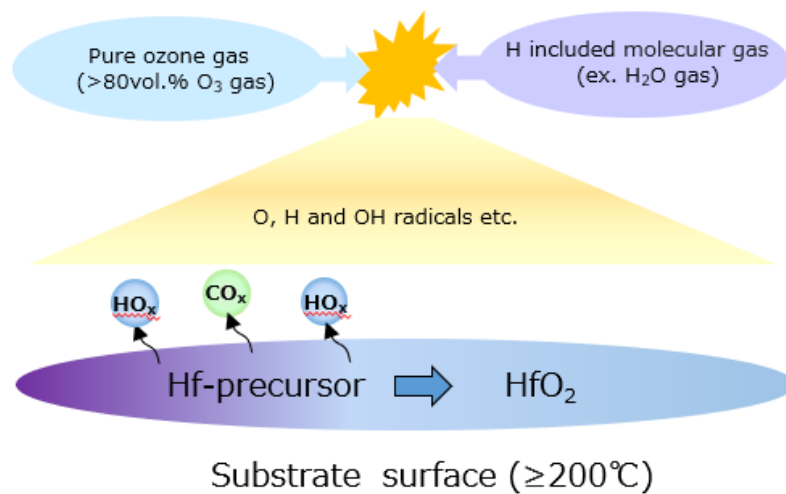


Fig. 2 . Schematic images of oxidation step of ALD for the HfO₂ film deposition. Thermal assistance from heating the substrate surface activates the reaction between pure ozone and hydrogen-included molecular gas, generating various radicals including OH radicals.

This work

Film qualities \ Oxidation sources	Pure ozone +H included molecular gas	O ₂ plasma	Pure ozone	Ozonizer ozone
Electric properties (Ex. dielectric)	○	○	△	△ ⁻
Step coverage	○	×	○	○ ⁻
Productivity (Batch processing)	○	×	○	○ ⁻

Table. 1. Comparison table of the expected Hf₂O film quality using various oxidation species. Relative evaluation between O₂ plasma, pure ozone and ozonizer ozone based on the film quality already obtained for Al₂O₃ and SiO₂ films.