Supplement to "Design of Gas Flow Field for a Slip Flow ALD Processing Chamber"

The continuity, momentum and energy equations of a steady-state compressible laminar flow field for the nitrogen gas in the ALD chamber are considered as follows.

$$\textbf{Continuity}\ \frac{\partial}{\partial x_j}\left(\rho U_j\right)=0$$

$$\textbf{Momentum}\ \frac{\partial}{\partial x_j}\left(\rho U_j U_i\right)=-\frac{\partial P}{\partial x_i}+\frac{\partial \tau_{ij}}{\partial x_j}-\rho g\delta_{i3}\,,\qquad \textbf{Stress tensor}\ \tau_{ij}=\mu\left(\frac{\partial U_i}{\partial x_j}+\frac{\partial U_j}{\partial x_i}-\frac{2}{3}\frac{\partial U_k}{\partial x_k}\delta_{ij}\right)$$

$$\textbf{Energy}\ \frac{\partial}{\partial x_j}\left(\rho U_j E\right)=-\frac{\partial (PU_i)}{\partial x_i}+\frac{\partial\left(\tau_{ij}U_i\right)}{\partial x_j}+\frac{\partial}{\partial x_j}\left(k\frac{\partial T}{\partial x_j}\right)-\rho g U_i\delta_{i3}\,,\qquad E=h-\frac{P}{\rho}+\frac{1}{2}U_k U_k$$

where ρ, U, P, T, μ, h and δ are the density, velocity, pressure, temperature, molecular viscosity, enthalpy of the gas and the Kronecker delta, respectively, and the subscripts i, j=1, 2 and 3 are the tensor components.

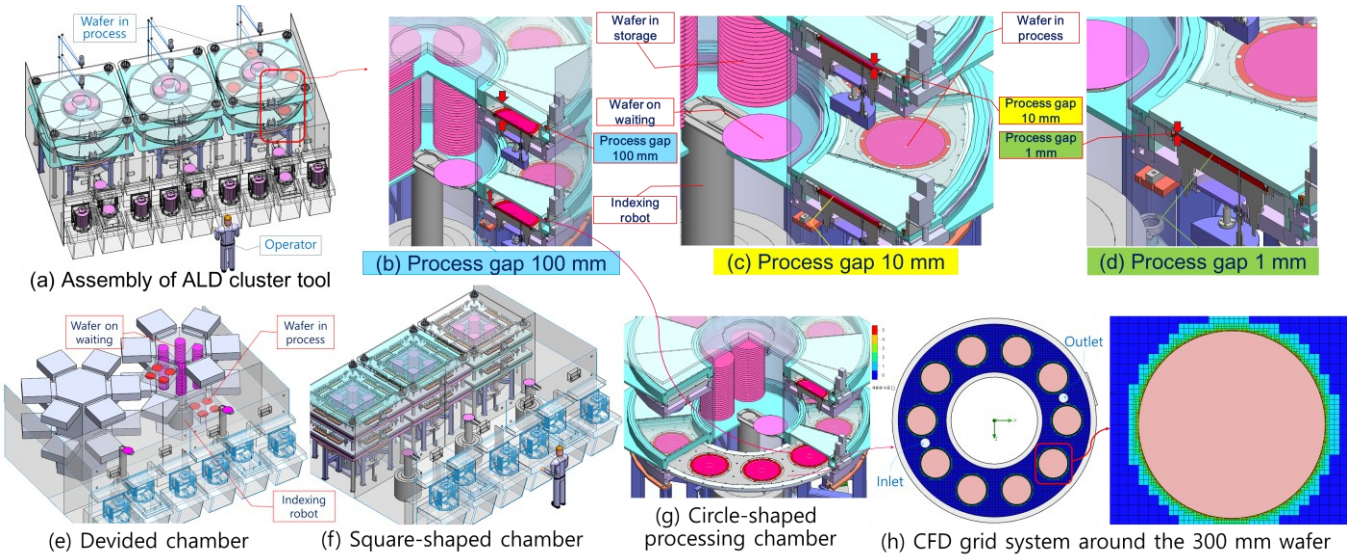

Fig. 1. Schematic diagram of the present ALD processing chamber and cluster tool for 300 mm wafers.

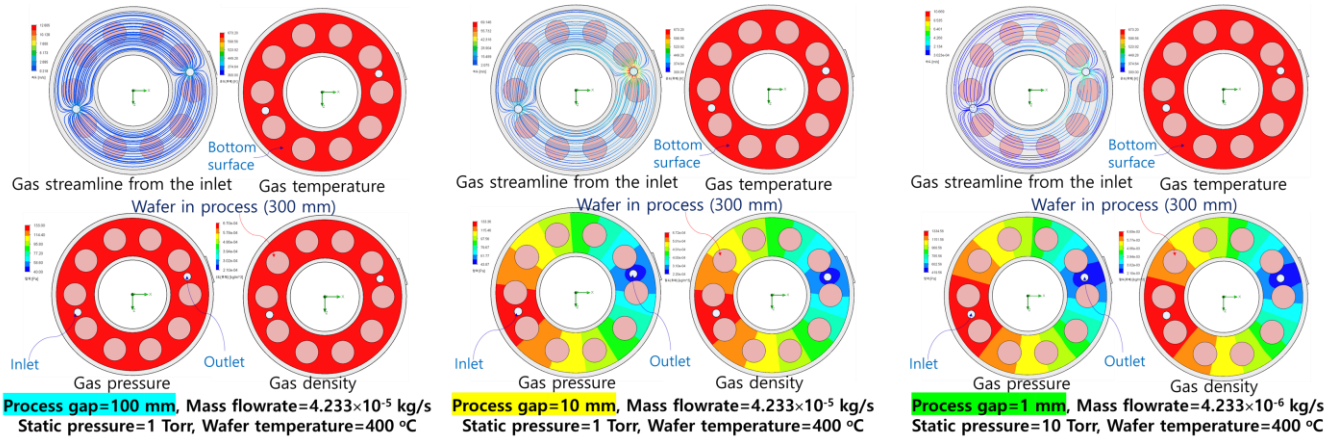

Fig. 2. Numerical results of the nitrogen gas flow fields for various operational conditions of the present ALD processing chamber.