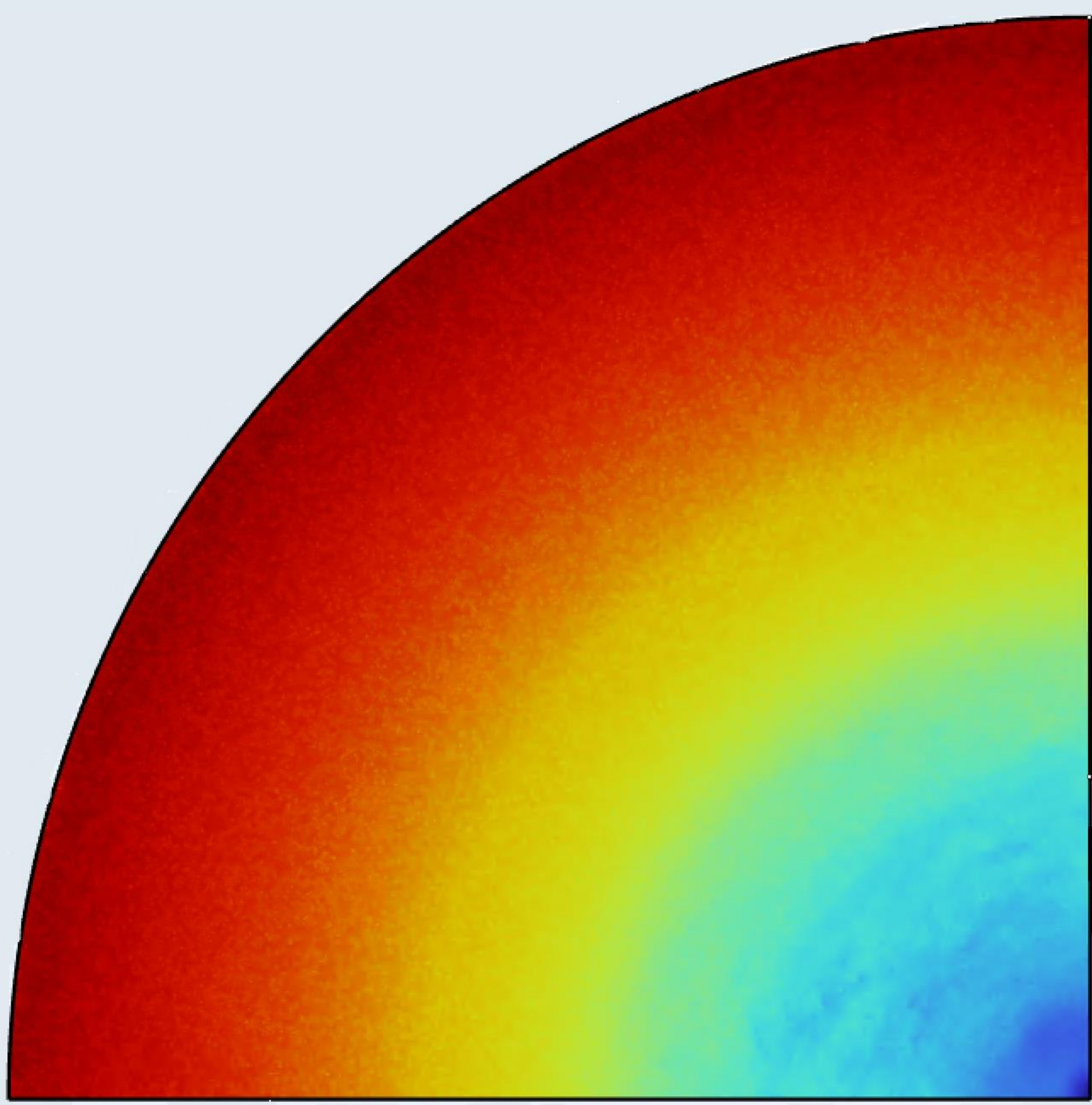

Simulation-Driven Design of Showerhead for Uniform Wafer Deposition

Analyze the effect of geometrical and flow parameters on uniformity near wafer zone.

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Introduction & Goals

Chipmakers widely use the plasma-enhanced chemical vapor deposition (PECVD) technique for depositing thin dielectric or conducting films on wafers. The primary objective for a deposition process is to have a good flow and species uniformity on the wafer. Typically, a carefully designed showerhead is used to deliver the precursor gas. A flow model available with commercial code COMSOL is used to analyze, design and achieve the objective. Effect of geometrical and flow parameters on flow uniformity near wafer zone have been studied.

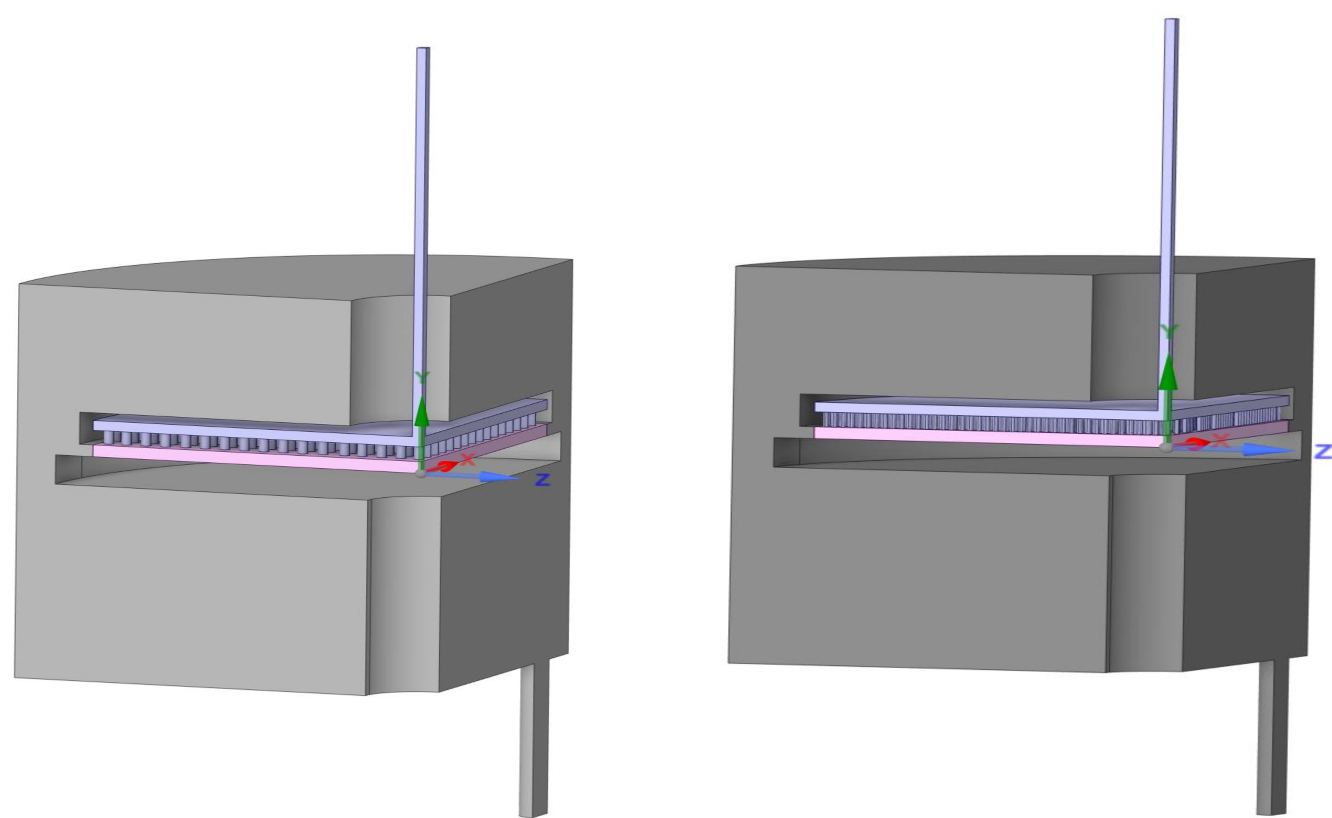

FIGURE 1. Left: model1 with lower hole density. Right: model2 with higher hole density.

Methodology

Steady state laminar flow from showerhead has been modeled to evaluate the flow uniformity near the wafer zone. A quarter symmetric 3D model is used to reduce the computational time and effort.

Effect of different parameters i.e., flow rate, chamber pressure, process gap (gap between showerhead and pedestal) and hole density on flow uniformity have been studied.

Results

Figure 2 shows the velocity distribution near the wafer zone at 100 sccm flow rate on left and flow non uniformity variation at different flow rate, pressure and process gap on the right for model1 and model2.

Flow non uniformity increases by increasing the flow rate and showerhead hole density. Increasing flow rate and hole density provide additional jetting effect near the wafer zone which results in flow to be more non uniform.

Effect of increasing pressure does not have significant impact on flow non uniformity.

Increasing process gap may increase or decrease the flow non uniformity depending the hole's pattern and hole density.

Extensive further studies need to performed on various other showerhead designs to confirm the observed trend in the above study.

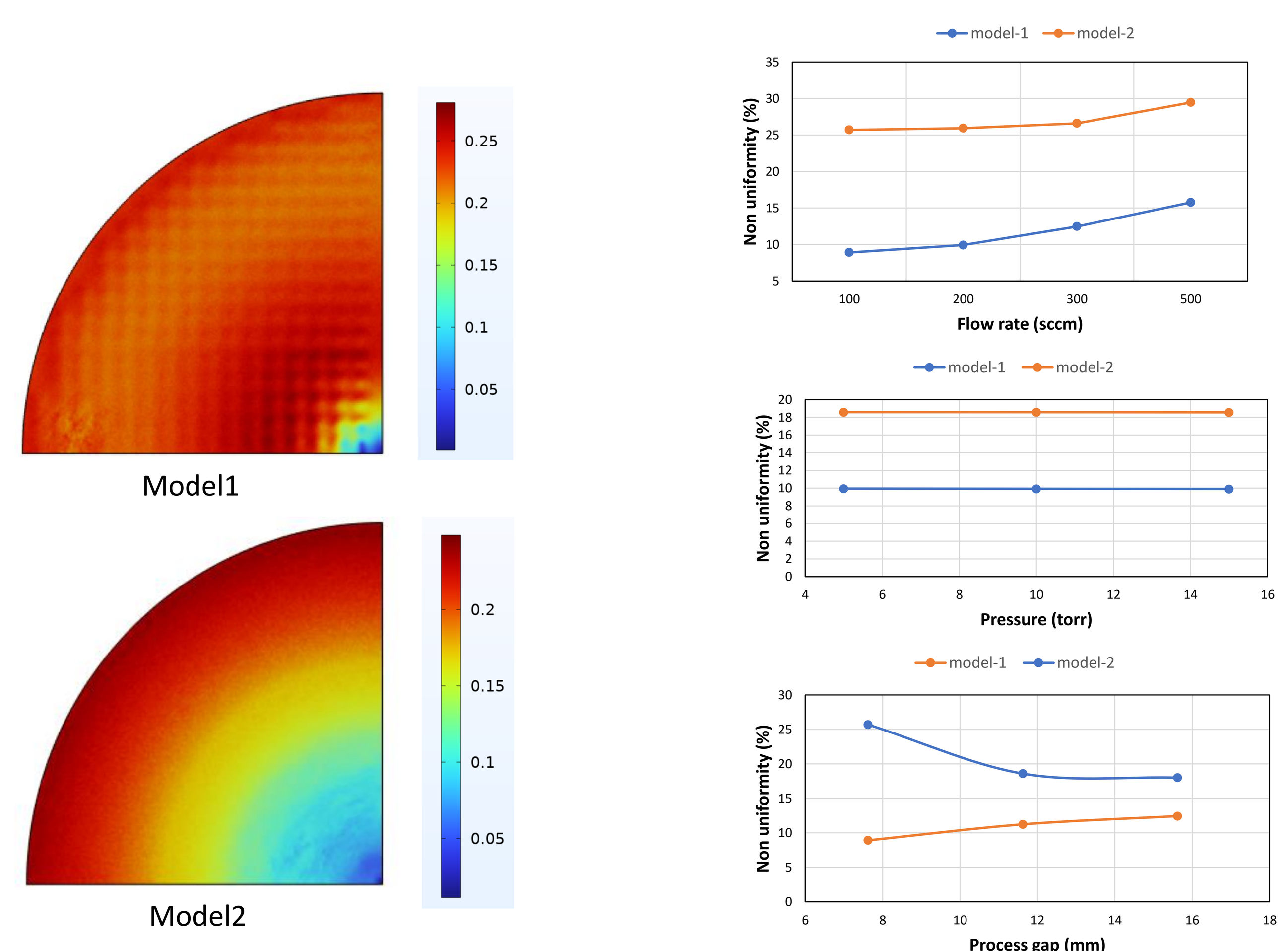

FIGURE 2. Left: Velocity distribution (m/s) for model1 & model2. Right: Flow non uniformity (%) vs flow rate (sccm), pressure (torr) and process gap (mm)

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