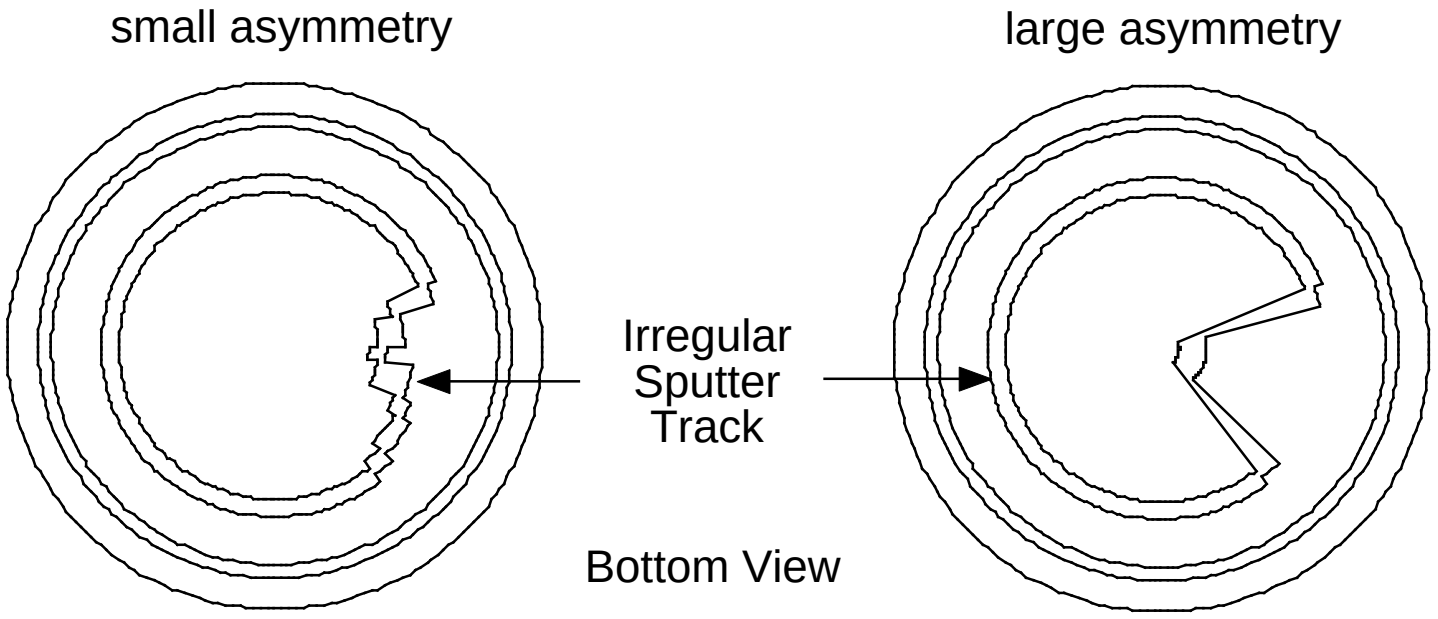
IMPVD REACTOR-IRREGULAR TARGET:

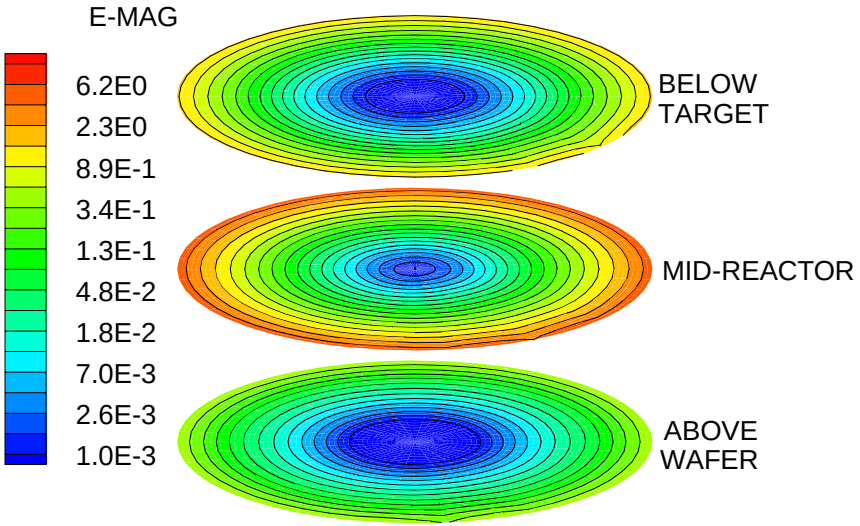
SMALL AND LARGE ASYMMETRY

- Irregular target with small and large asymmetry, similar to the heart-shaped sputter track, are used in this study.
- To isolate the asymmetry due to the irregular target, symmetric excitation is applied.

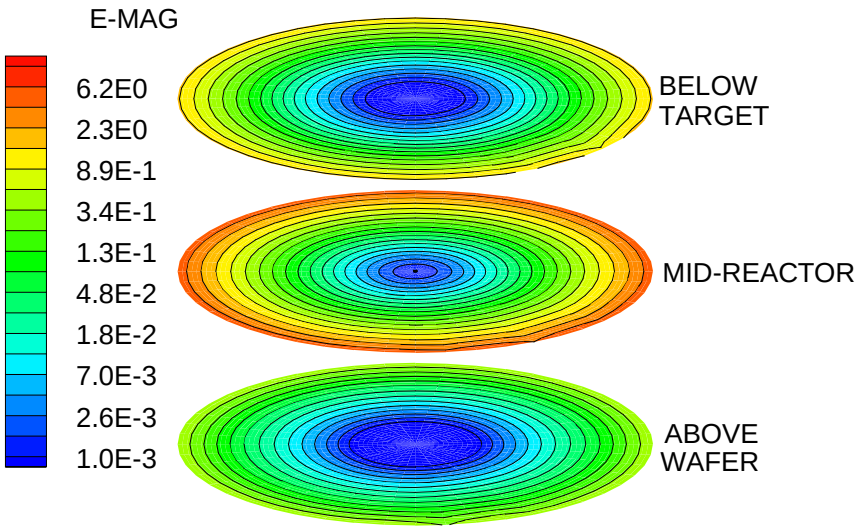


IMPVD REACTOR-IRREGULAR TARGET, SYMMETRIC EXCITATION:
ELECTRIC FIELD

- The irregular sputter tracks have little effect on the electric field.



- small asymmetry



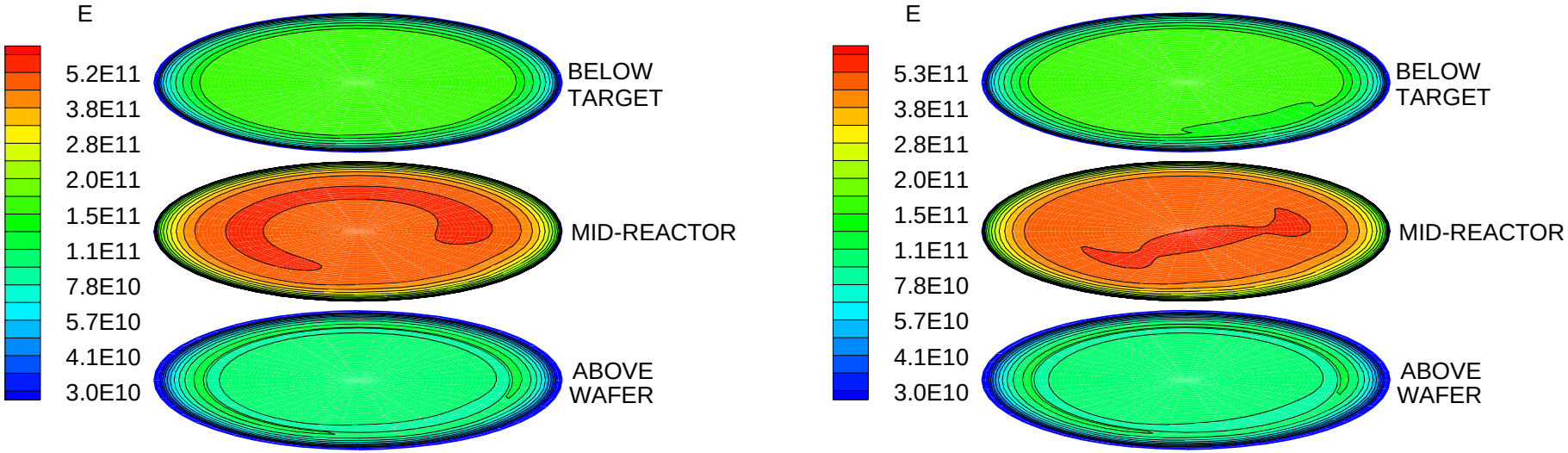
- large asymmetry

E-field (V/cm)

- Ar, 10 mTorr, Al target, 600 W, H/R = 0.5

IMPVD REACTOR-IRREGULAR TARGET, SYMMETRIC EXCITATION:
ELECTRON DENSITY

- The electron densities are asymmetric at mid-reactor, due to the irregular sputter track and high electric field.
- The electron densities are symmetric and uniform above the wafer, due to diffusion.



small asymmetry

Electron density, (cm^{-3})

large asymmetry

- Ar, 10 mTorr, Al target, 600 W, H/R = 0.5

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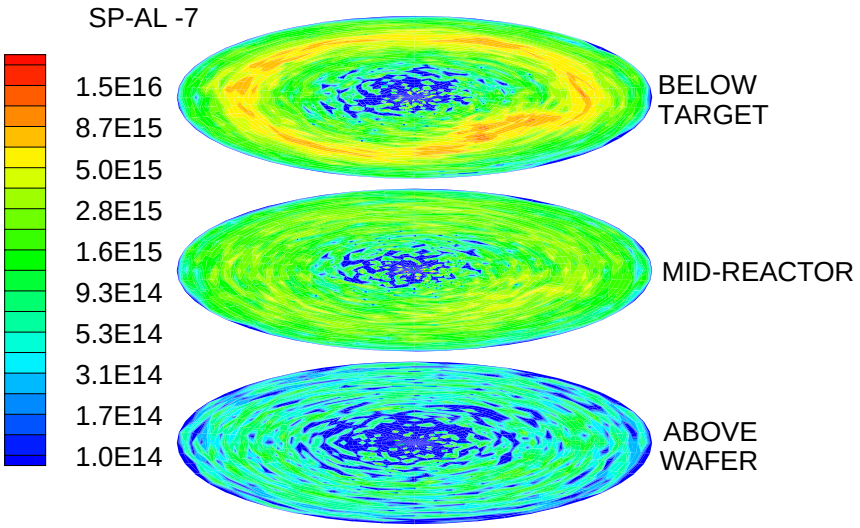
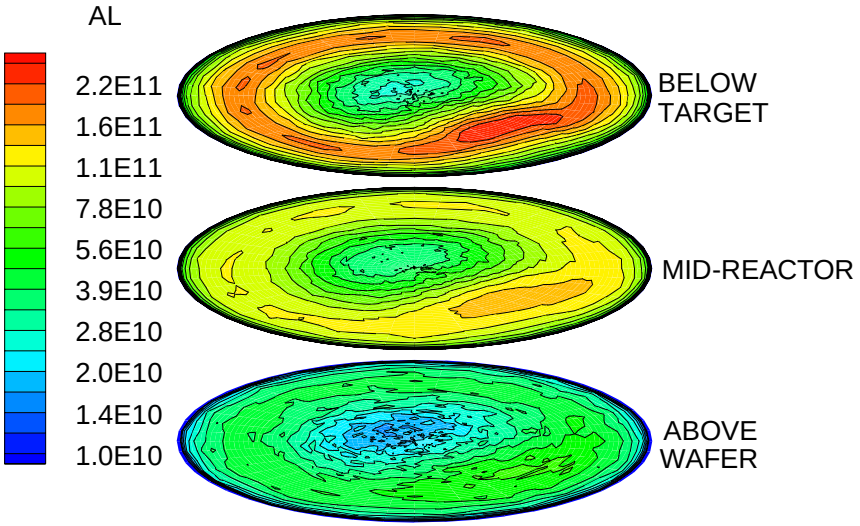
IMPVD REACTOR-IRREGULAR TARGET, SMALL ASYMMETRY, SYMMETRIC EXCITATION: Al SPECIES

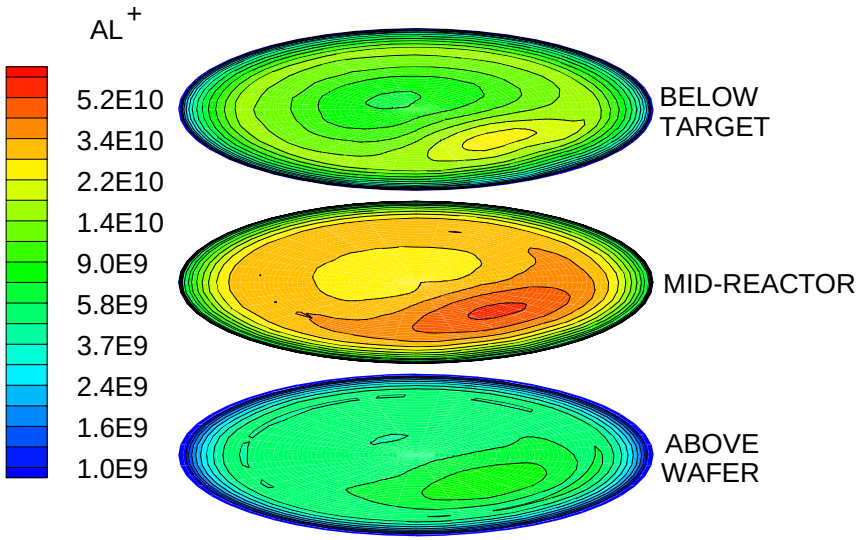


- Al sputter source, ($cm^{-3}s^{-1}$)



- Al density, (cm^{-3})

- The asymmetry of sputter track causes asymmetry in Al sputter source, which causes asymmetry in Al atom and Al^+.
- The asymmetry in Al atom and Al^+ persists to the wafer.



- Al^+ density, (cm^{-3})

- Ar, 10 mTorr, Al target, 600 W, H/R = 0.5

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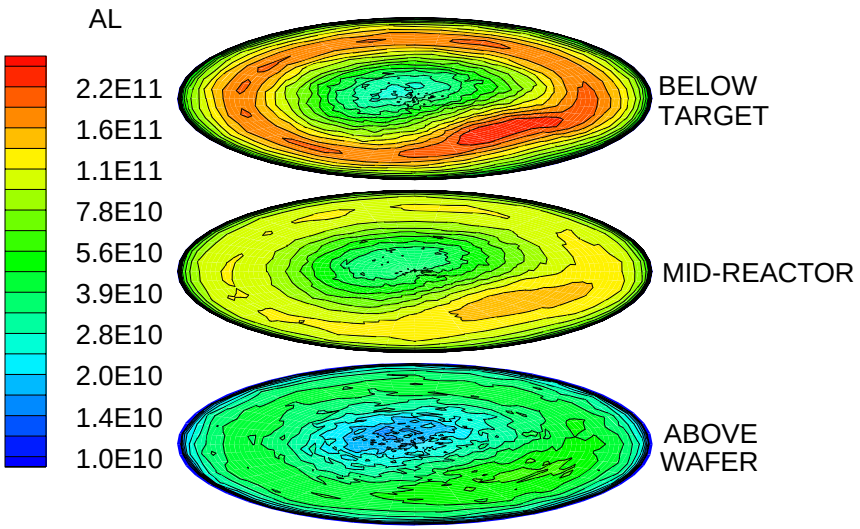
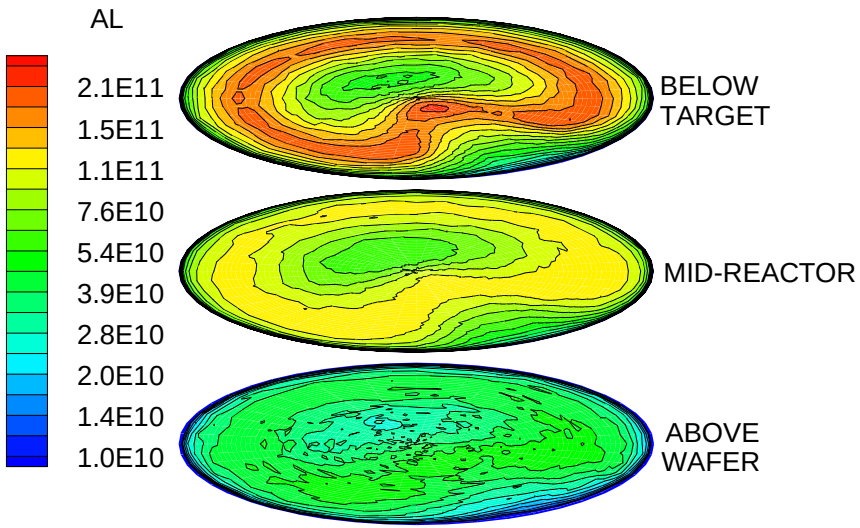
IMPVD REACTOR-IRREGULAR TARGET, SYMMETRIC EXCITATION:

Al ATOM DENSITY

- Both Al densities peak below the sputter track, and then decrease toward the wafer because of losses to the wall.
- The Al density for the large asymmetry case is more uniform above the wafer, because the sputter track near the center provides sputter source there, and some Al atoms diffuse to the center.



small asymmetry



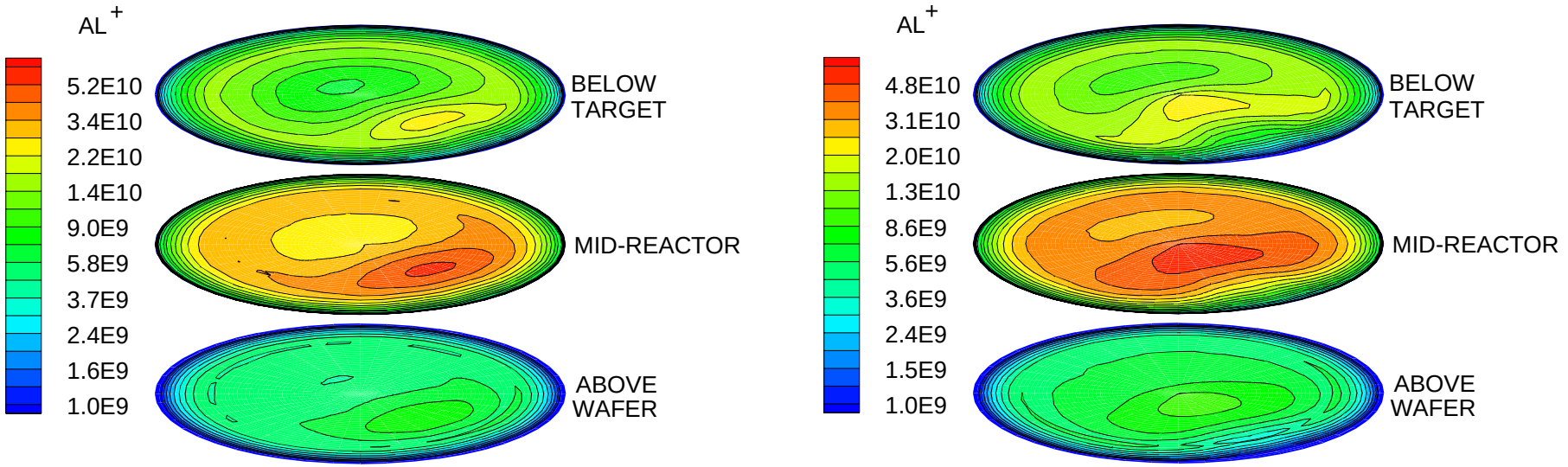
large asymmetry

Al density, (cm^{-3})

- Ar, 10 mTorr, Al target, 600 W, H/R = 0.5

IMPVD REACTOR-IRREGULAR TARGET, SYMMETRIC EXCITATION:
Al ION DENSITY

- Both Al^+ densities peak at the mid-reactor, consistent with the electric field.
- The Al^+ density for the large asymmetry case is slightly more symmetric above the wafer because of the sputter track geometry.



small asymmetry

Al^+ density, (cm^{-3})

large asymmetry

- Ar, 10 mTorr, Al target, 600 W, H/R = 0.5

CONCLUSIONS

- Poor impedance matching of the coil can produce asymmetric excitation rates in IMPVD systems.
- Irregular sputter track can lead to asymmetric sputter source, therefore asymmetric sputter metal species in IMPVD systems.
- In rare gas-metal chemistries, the rare gas ion densities retain the asymmetric profiles while the lower ionization potential, higher mobility metal ions and atoms have more uniform densities.
- The asymmetry in the depositing metal flux diminishes more as aspect ratio increases, at the expense of decreasing magnitude of the depositing flux.
- Proper antenna and target design is required to generate uniform metal flux to the wafer.