Visualization of Precursor Transport in Vapor Deposition Systems: Measurements and Simulations

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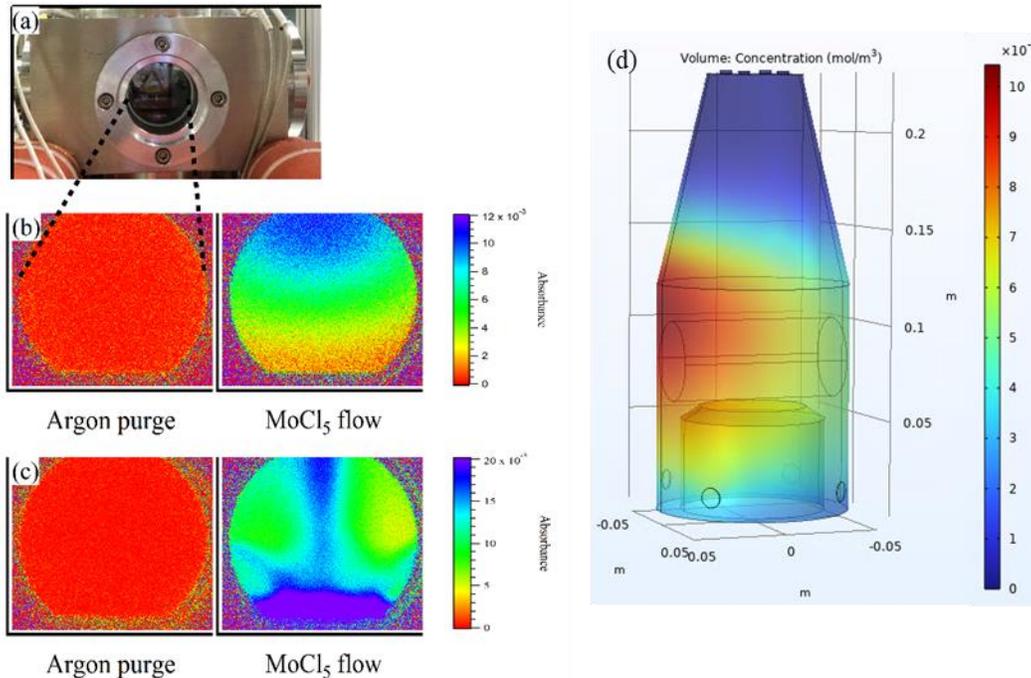
Figure 1. Absorption images obtained for two gas flow conditions for $MoCl_5$ delivery: (a) is an image of the deposition chamber window (42 mm diameter field of view), (b) is a $MoCl_5$ absorption image during argon-only purge and during $MoCl_5$ flow for a 0.4 slm total gas flow rate in the chamber at a pressure of 190 Pa, and (c) is a $MoCl_5$ absorption image during argon-only purge and during $MoCl_5$ flow for a 2 slm total gas flow rate in the chamber at a pressure of 2.4 kPa. During the argon purge, no $MoCl_5$ flows and, hence, absorbance is zero. The $MoCl_5$ flow conditions corresponding to (b) result in a relatively uniform precursor concentration front impinging on the wafer surface and the precursor being efficiently exhausted from the chamber. In contrast, the $MoCl_5$ flow conditions corresponding to Fig. (c) result in a jet to the wafer surface and recirculation zones along the chamber walls. (d) shows a CFD simulation of $MoCl_5$ flow at 1.7 s after injection into the chamber and for a 0.4 slm total gas flow rate in the chamber at a pressure of 190 Pa is shown in the figure at the bottom and to the right (the Absorbance/concentration color scale is inverted compared to the top figure). It is clear that with a validated simulation, more information about precursor flow in the chamber can be deduced than with only measured pathlength-integrated precursor concentration and total pressure.