Chemical Vapor Deposition Reactor System Integration and Optimized Vapor Shield Design

San Diego State University

Project Overview

Problem Statement:
Chemical vapor deposition (CVD) is a vacuum-based process used to fabricate conductive polymer thin films. The functionality of the oCVD Reactor depends on the ability of the oxidant and the monomer vapors to react with each other and settle on a substrate. There is a need to increase this "deposition rate" inside of the reactor in order to improve the film quality.

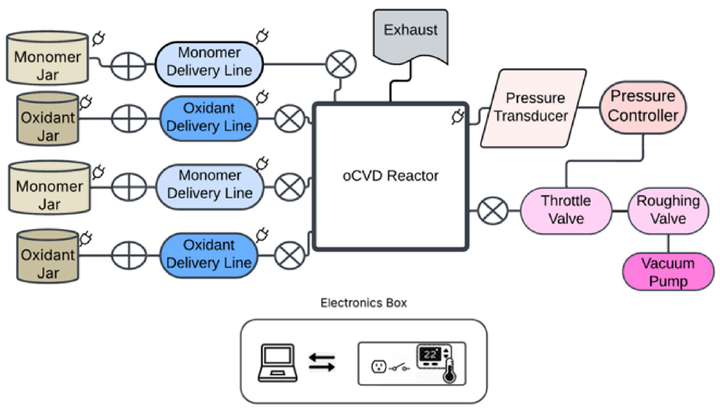
Task:
Make an insertable part that will increase the deposition rate.

Solution:
To meet this need, an optimized vapor shield is designed and fabricated to improve deposition rates and precursor yield in the oCVD reactor. It does this by decreasing the internal area around the substrate and by increasing the velocity of the vapors across the surface of the substrate. These two things effectively increase the deposition rate based on the Mass Flux Particle Deposition Equation below.

$$\vec{J} = -D\nabla n + n\vec{v}_p$$

$\vec{J}$: Mass Flux (Deposition)
n: particle number concentration
$\vec{v}_p$: Particle velocity
D: Brownian diffusivity

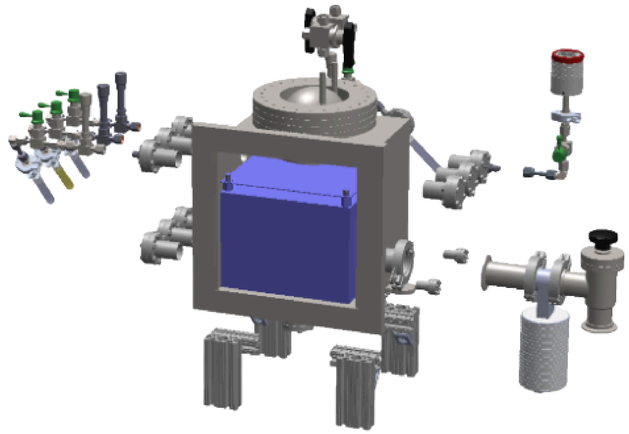
System Level Diagram



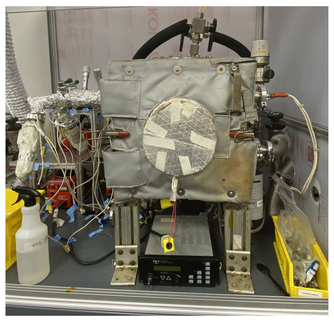
Meet the Team

Zack Melland | Naomi Chuang | Ella Helge | Alex Christiansen | Connor Malech

oCVD Reactor DIAGRAM



What is an oCVD Reactor?



An oxidative chemical vapor deposition (oCVD) reactor is a system that forms thin polymer films by reacting vaporized monomer and oxidant directly on a substrate surface. The process occurs under controlled temperature and low-pressure conditions, around 50 mTorr, allowing polymerization to occur. This enables uniform, high-purity coatings on complex or sensitive materials that are difficult to coat using traditional methods.

Manufacturing

Material

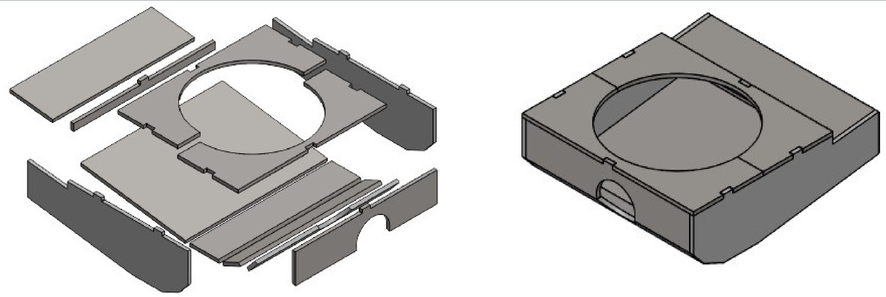
304 Stainless Steel

Methods Used

Vapor Shield:
- Water Jet
- TIG Welding

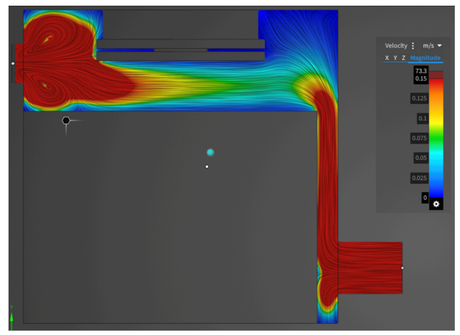
Welding Jigs:
- 3D Printing
- CAM for Wood Jigs

Final Design

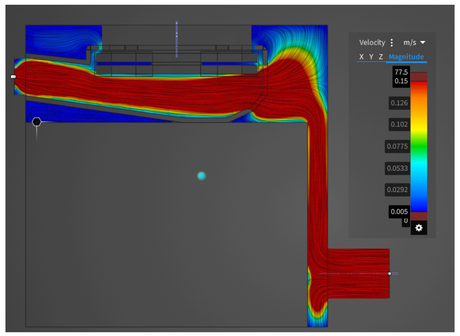


Vapor Shield Exploded and Assembled View

Computational Fluid Dynamics Simulation



Without Vapor Shield

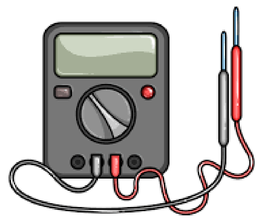


With Vapor Shield

Testing

Two Possible Paths for Testing Deposition Rate

- Use of a high powered microscope to measure thickness of deposition.
- Multimeter to measure conductivity of the substrate, the faster the deposition, the less conductive the material.



Acknowledgements

Team Perseus would like to thank the following people for supporting the development of the project:
Dr. Scott Shaffar
Dr. Meysam Heydari Gharahcheshmeh
Ravjiv Mangukia
Kafil Chowdhury
Advanced Manufacturing of Energy Devices Laboratory
SDSU Department of Mechanical Engineering