Atomic Layer Deposition

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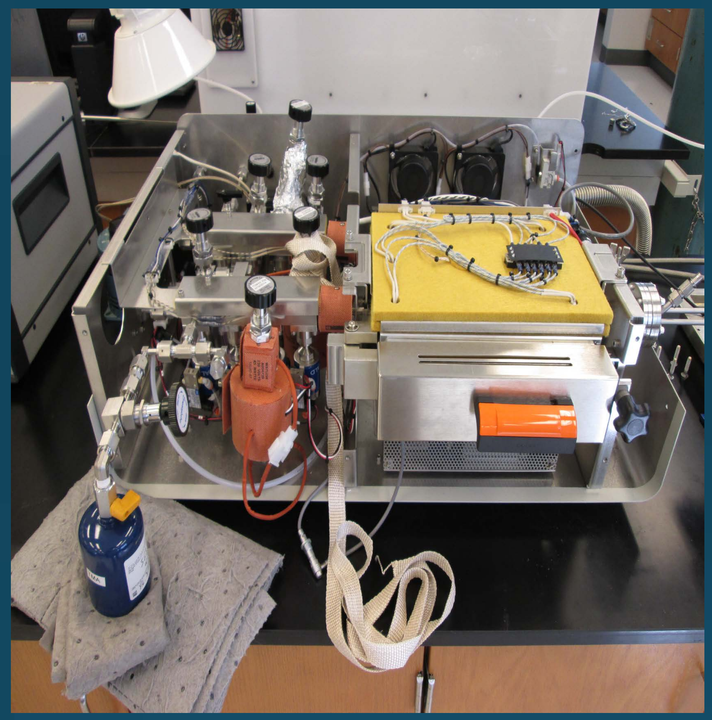
Introduction

Atomic layer deposition (ALD) is a technology that deposits thin films onto a substrate for an immense variety of applications. ALD applies the film layer with a thickness of one atom, allowing for a layer that is uniform throughout the substrate. Other current technologies, such as chemical vapor deposition (CVP) , can apply thin layers, but in a non-uniform manner on 3D substrates, which affects various desired properties, such as catalytic activity. The reactants are applied to the substrate one at a time, allowing a layering effect of chemical reactions, until the desired film thickness is achieved.

Review of Literature

Literature was found on OneSearch in the UAH Louis Salmon Library using the keywords atomic layer deposition, catalyst, and hydrocarbons. The background of the article states that catalytic combustion is a widely used method for removing harmful VOCs from products. However, oxidation occurs at high temperatures. Proper oxidative catalysts can be used to lower the combustion temperature. Noble metal catalysts have been used before but are limited due to the high cost. Nickel oxide catalysts have less activity than noble metal catalysts, but more potential due to lower cost. An experiment was performed using ALD to deposit NiO on a mesoporous SiO_2 substrate and the catalytic activity was compared to that of commercially available NiO catalysts. The experiments showed that catalytic activity of NiO using ALD increased through 40 ALD cycles, but was reduced from 40 to 80 cycles. Additionally, the NiO catalyst on SiO_2 using ALD was found to have greater catalytic activity than other unsupported commercially available NiO catalysts.



ALD Procedure

The first step in ALD is to place a substrate, such as SiO_2, into the ALD machine. The deposition cycle begins with a nitrogen purge of the carrier lines. Next, a precursor is carried by the carrier gas into the reaction chamber, where a layer of one atom thickness reacts with the substrate. Again, the lines are purged with nitrogen to remove any unreacted species. An oxidant is then allowed to flow into the reaction chamber where a reaction with the precursor occurs. The chamber is then purged one more time. The deposition process is repeated until the desired layer thickness is achieved.

History of ALD

ALD began in the 1960's when the technology was known as molecular layering. The first industrial application of the technology was in the manufacturing of electroluminescent flat panel displays, also known as LCD displays. Manufacture of LCD displays was the only industry using ALD in the 1980's. Increased interest in ALD technology occurred in the 1990's with the increased use of silicon based semiconductors in modern computers. Currently, ALD is used in applications such as solar panels, magnetic heads, memory devices, fuel cells, batteries, and sensors. The possibilities of ALD technology are endless.

References

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