

Accelerated Deployment of Nanostructured Hydrotreating Catalysts

Atomic Layer Deposition (ALD)

Argonne National Laboratory is contributing significant research effort in the area of nanomanufacturing catalysts. Atomic Layer Deposition (ALD) can produce catalysts with exceptional dispersion, uniformity, and controlled loading. These nanostructured catalysts could be the key to addressing process inefficiencies in the chemical and refinery processing industries. By improving reaction yields and product selectivity, new ALD catalysts should result in large energy savings and reduced GHG emissions.

Argonne's research reactors enable a range of metal oxide and metal films to be deposited onto high surface area catalyst supports. Up to 500 m² (0.2-5g) of catalyst support can be coated in a single deposition. A larger scale reactor for processing 10⁴ m² (100 g) batches using ALD deposition can be used to produce pilot-scale quantities of the most promising catalysts.

The Project

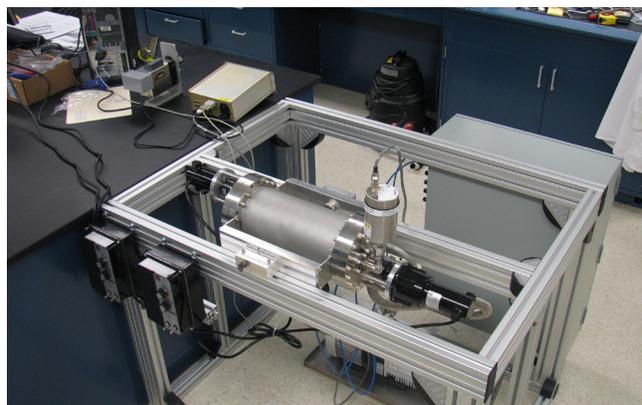
Argonne, Universal Lubricants Inc. (ULI), and chemical engineering partners are developing longer-lived hydrotreating catalysts for recycling used lubricant (lube) oil. The lube oil market is a multi-billion pound market that is highly dependent on imported petroleum and represents a substantial re-refining opportunity.

In this project, funded by the Industrial Technologies Program, Argonne will modify industrial partners' existing catalysts using ALD to improve activity. Researchers believe that the nanostructured catalysts will enable prolonged

operations at lower temperatures, extending the life of the catalysts, and improving economics. Energy savings are realized through avoided plant shutdowns and lower temperature operation.

ALD Catalyst Materials	
Metal oxides	Al ₂ O ₃ , MgO, ZnO ₂ , SnO ₂ , V ₂ O ₅ , Nb ₂ O ₃ , MoO ₃ , Fe ₂ O ₃ , TiO ₂ , CeO ₂ , ZrO ₂
Metals	Tungsten (W), Platinum (Pt), Palladium (Pd), Ruthenium (Ru), Iridium (Ir), Tin (Sn), Copper (Cu)
Catalyst supports	Aluminas, silicas, SBA-15, MCM-41, anodic aluminum oxide, carbon nanotubes

Examples of materials to be used in ALD



Argonne's custom ALD system for fabricating 10⁴m² surface area nanostructured catalysts

A fully ALD-synthesized catalyst based on knowledge of existing ones will also be evaluated as an alternative improvement strategy. Candidate catalysts are being produced and tested at Argonne. The best performing catalysts will be manufactured at 100 g quantities ($\sim 10^4$ m² surface area) and evaluated in slipstreams at ULI's plant.

Unique Opportunity

We believe that the ALD platform will enable accelerated fabrication, optimization, and deployment of nanostructured catalysts. This project is the pioneer attempt.

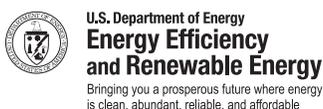
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