

BASF Virtual Round Table X3D, April 22, 2026

X3D[®] – Reactor-driven catalyst design

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 **BASF**
We create chemistry

What can you expect today?

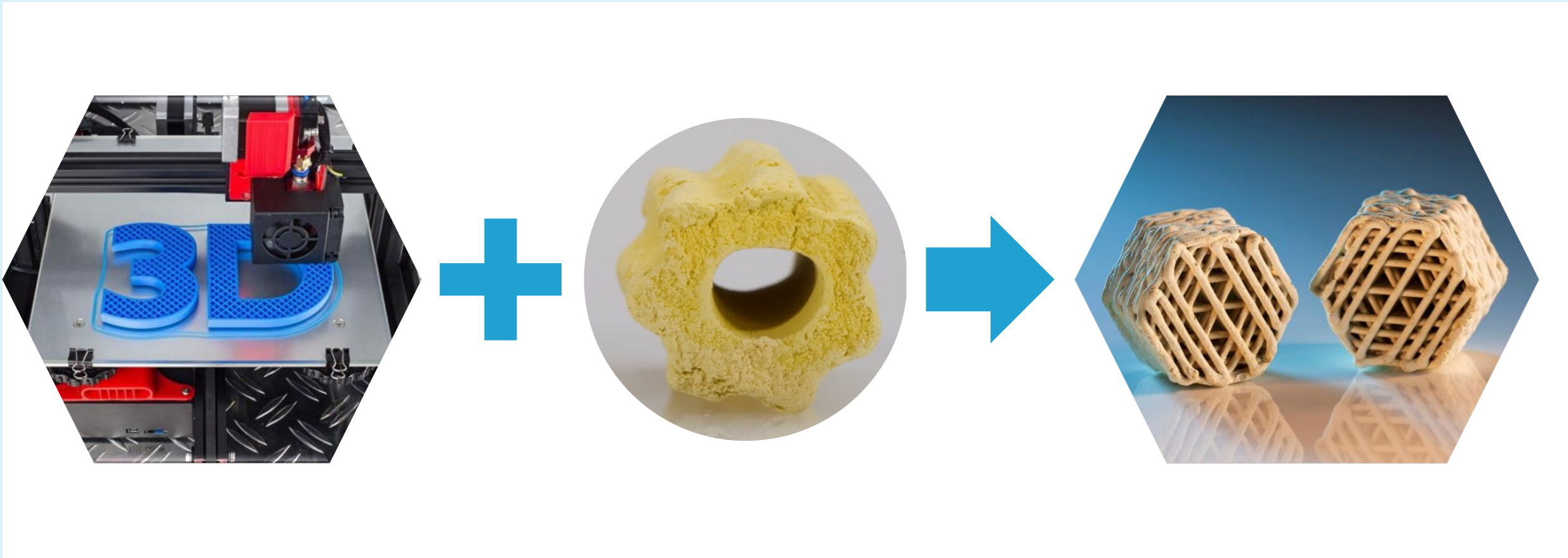
Why additive manufacturing for catalysts?

What are the benefits for customers?

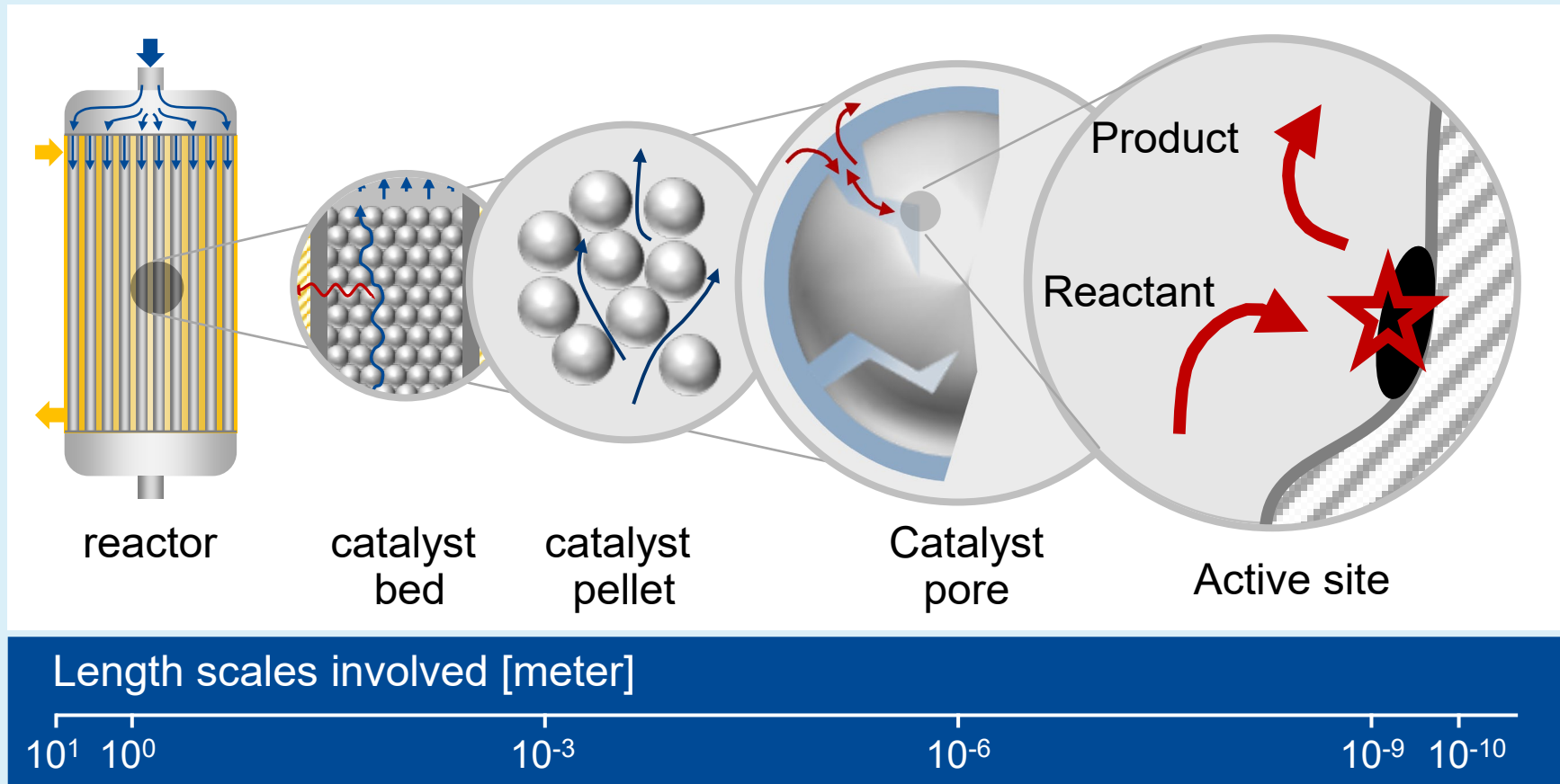
How is the impact in real plants?



Additive manufacturing of catalysts



Catalysis is a multi-scale challenge...

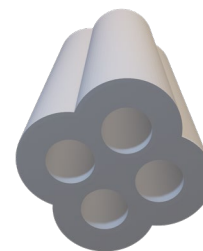
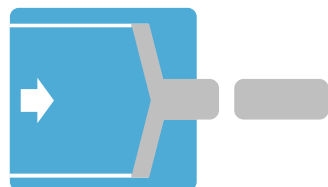


Catalysis is a multi-scale phenomenon with a complex interplay between reaction and transport on all length scales!

How are catalysts made?

Shaping:

Extruding
since 1930s



Tableting
since 1950s

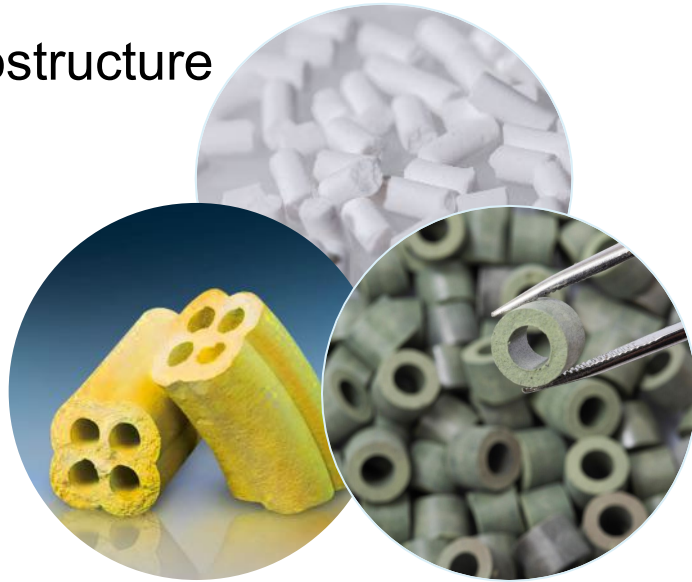


No major
manufacturing
innovation
in the past
70 years

What are the challenges and the need for innovation in shaping?

Challenges by

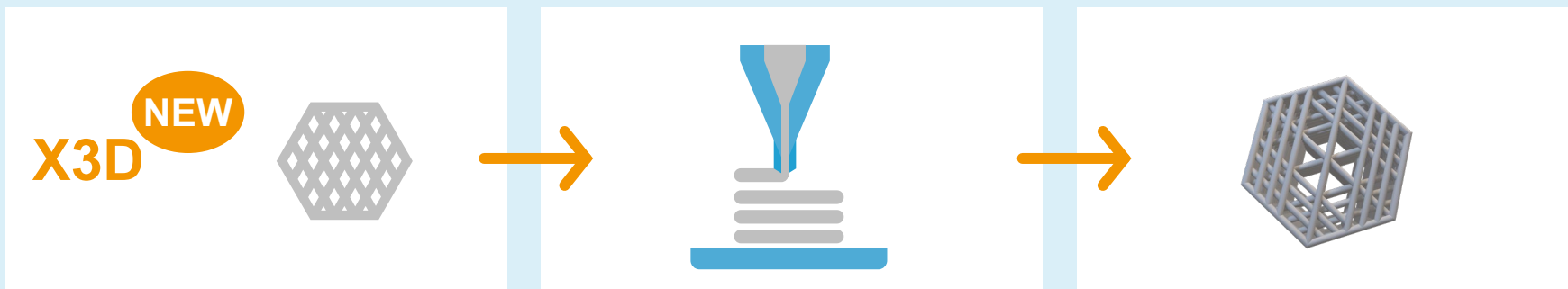
- Limited shape design
- Missing microstructure



What customers expect

- Increased productivity
- Improved resource efficiency
- Reduced CO₂ emissions
- Supply at scale

X3D – The new shaping technology



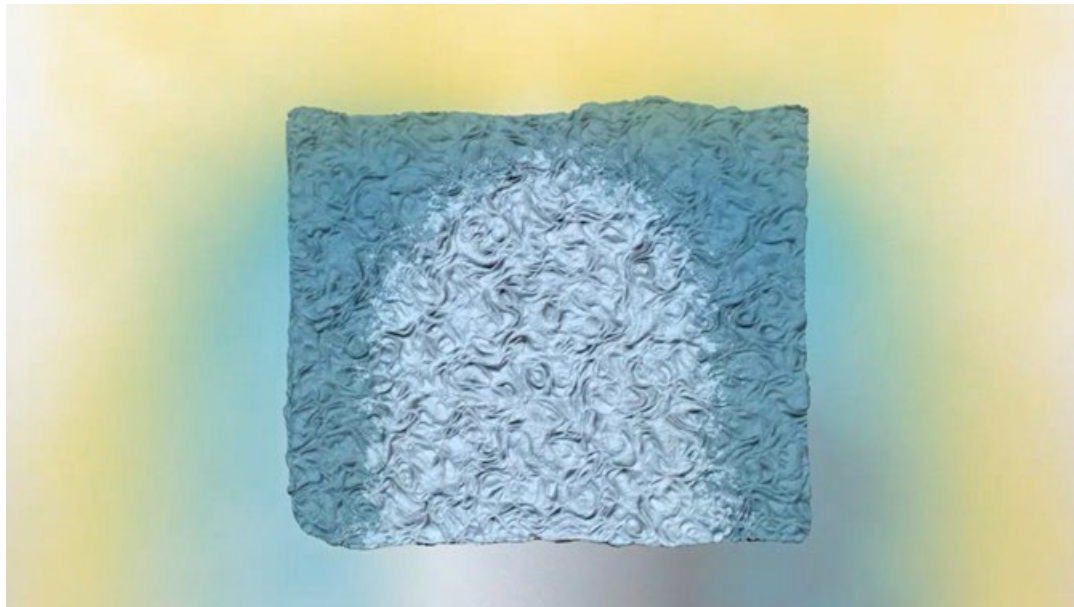
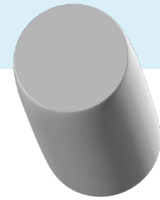
X3D offers a large number of improvements

- More open and accessible shapes
- High geometric surface area
- Production on industrial scale
- Fast prototyping

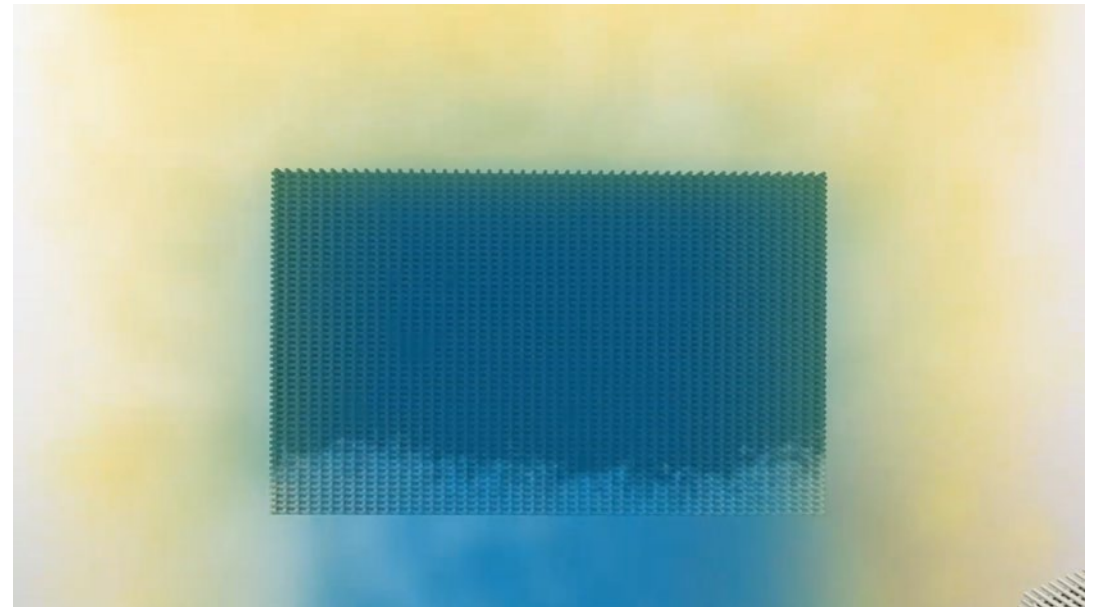
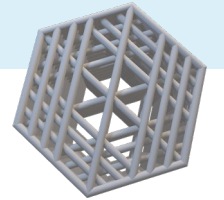


Benefits of X3D technology

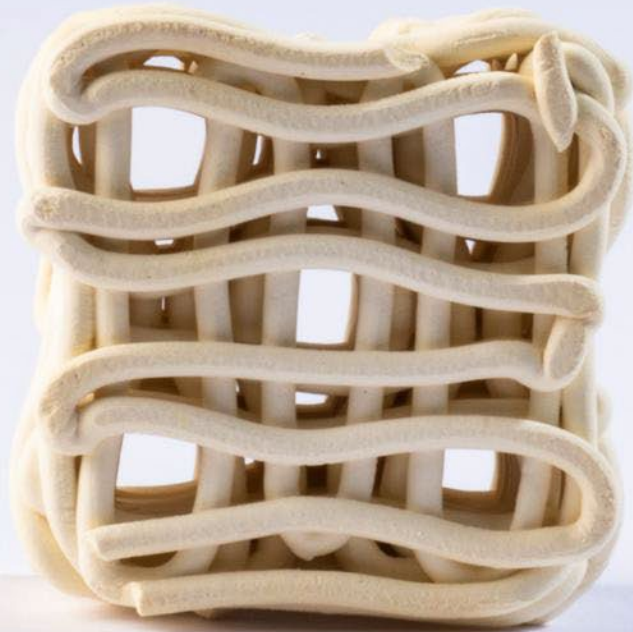
Partial use of catalyst mass



Full use of catalyst mass



Benefits of X3D technology



Optimized performance

More open and accessible shapes

Meeting customer demand

Production on industrial scale

Efficient use of raw material

High geometric surface area

Increased speed to market

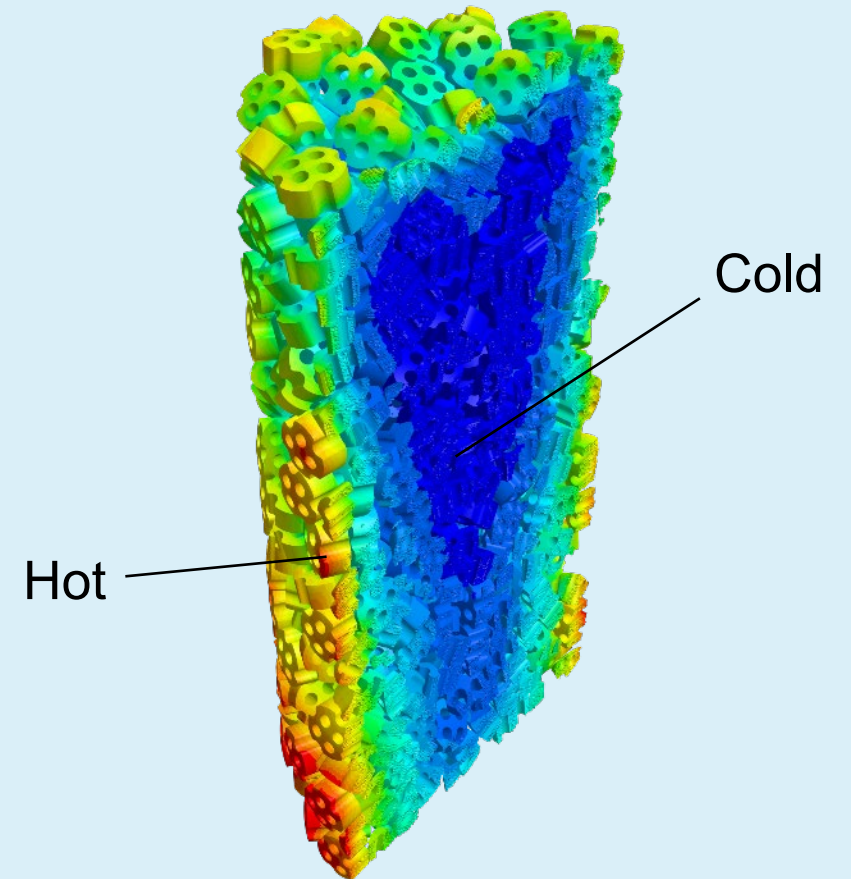
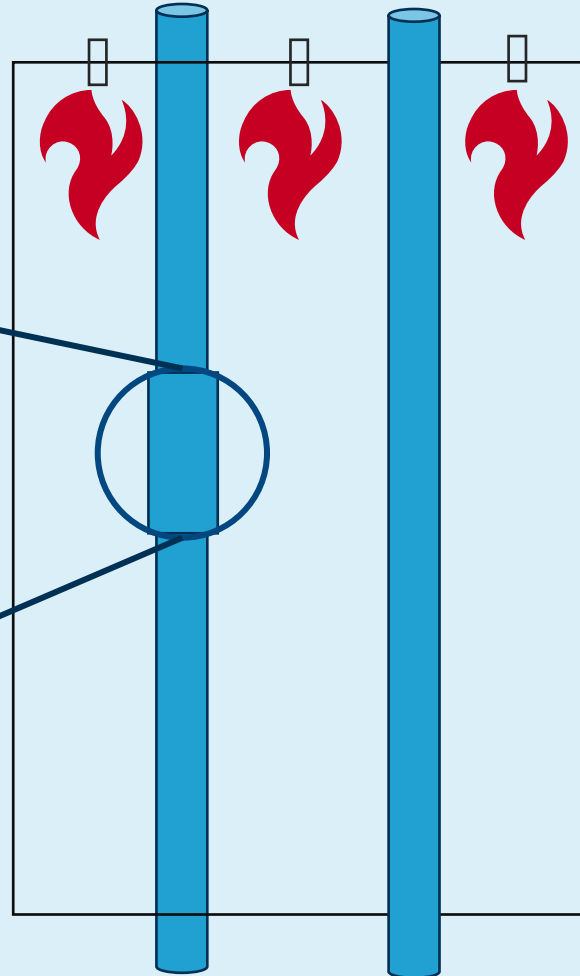
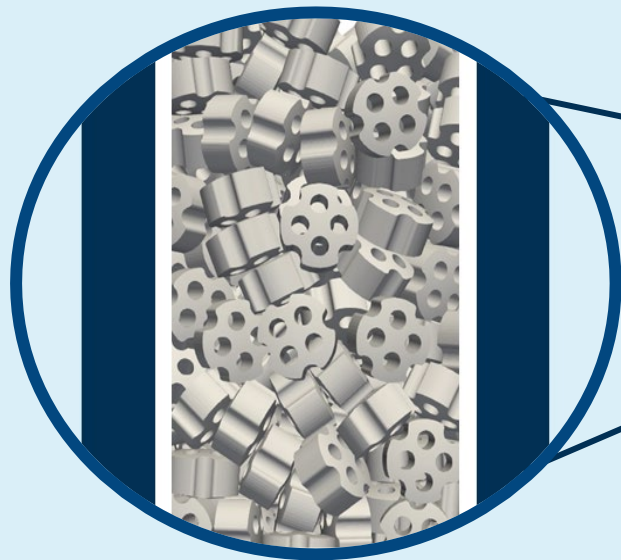
Fast prototyping

Example 1: Solving shaping challenges in reformer catalysts

Top fired reformer

CFD Simulation




Heat transfer tube wall
Film heat transfer



Pressure drop

Carbon formation on catalyst

Example 1: Performance gains with G1-110 X3D shapes

	SYNSPIRE® G1-110 T15 4F 	SYNSPIRE® G1-110 X3D® 	SYNSPIRE® G1-110 S1.2 
Production technology	Tableting	X3D	Extrusion
Pressure drop [Pa]	~120	-35% _{rel}	+1000% _{rel}
Packed bed density [ton/m³]	1.0	-40% _{rel}	+10% _{rel}
Side crush strength [N]	~300	+30% _{rel}	-80% _{rel}
Surface area / Vol [m²/m³]	505	+60% _{rel}	+280% _{rel}

Data are verified experimentally.

Example 2: Customer case studies

X3D Sulfuric Acid Catalysts

First X3D catalyst reference: Sulfuric Acid (EMC Italy)

- Sulfonation plant (capacity: 32 MTPD*)
- One catalyst bed replaced with X3D catalyst (1.2 m³)
- Customer benefits by saving €101k/a and 383 tons CO₂e
 - Blower energy saving*: 106 MW/a or 18k€/a or 383 tons CO₂e
 - Higher yield: <1%, equals <1 MTPD** or 25k€/a
 - Caustic soda saving: 20.5 kg/h or 58k€/a or 50%
- Savings reached by only one of four catalyst beds exchanged to X3D[®] catalyst!
- Multiplication of success: 7 references running at the end of 2025

Since 2019,
successful sales
of X3D derived
products with
positive customer
feedback



Example 3: Customer case studies

X3D N₂O abatement catalyst

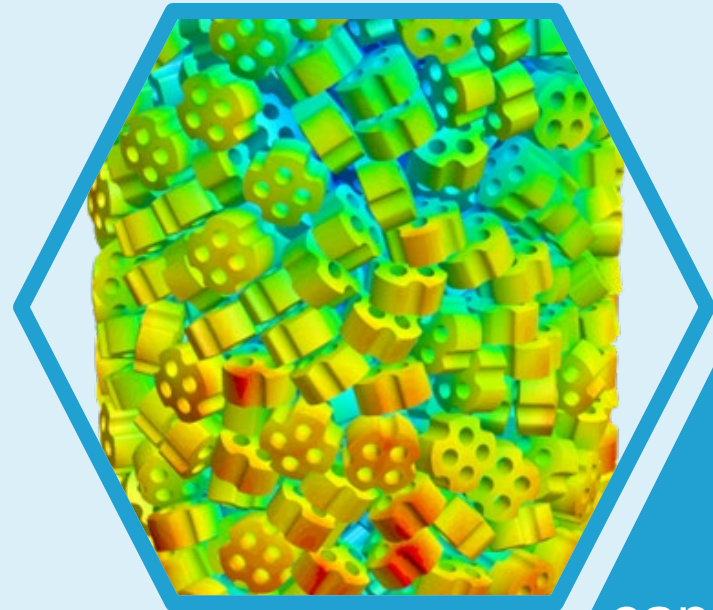
Second X3D catalyst reference: N₂O abatement catalyst

- Secondary N₂O abatement in Nitric acid plant
- Catalyst bed topped up with X3D catalyst (0.6m³)
- Customer benefits by saving >€3m/a* (CO₂e w/o energy)
 - Blower energy savings: up to 50%
 - CO₂e emission savings: >€3m/a* (compared w/o abatement)
 - **High N₂O removal rates at low investment costs compared to standard catalyst shapes**

O3-85 X3D catalyst already installed in a commercial plant for long-term operation since December 2023



Expanding capacity to meet rising demand

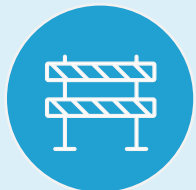


Additional
capacity now available
in Ludwigshafen



X3D gives us the freedom to design catalysts for the reactor - not the other way around

X3D is an enabler for:



Mass Transport

Yield optimization
Optimized CAPEX



Heat Transport

Hot spot control
Cold spot control



Pressure drop

Reduce pressure limits
Delay fouling

BASF can apply the technology to a wide variety of existing catalytic materials ...

... including base or precious metal catalysts and carrier materials.



We create chemistry