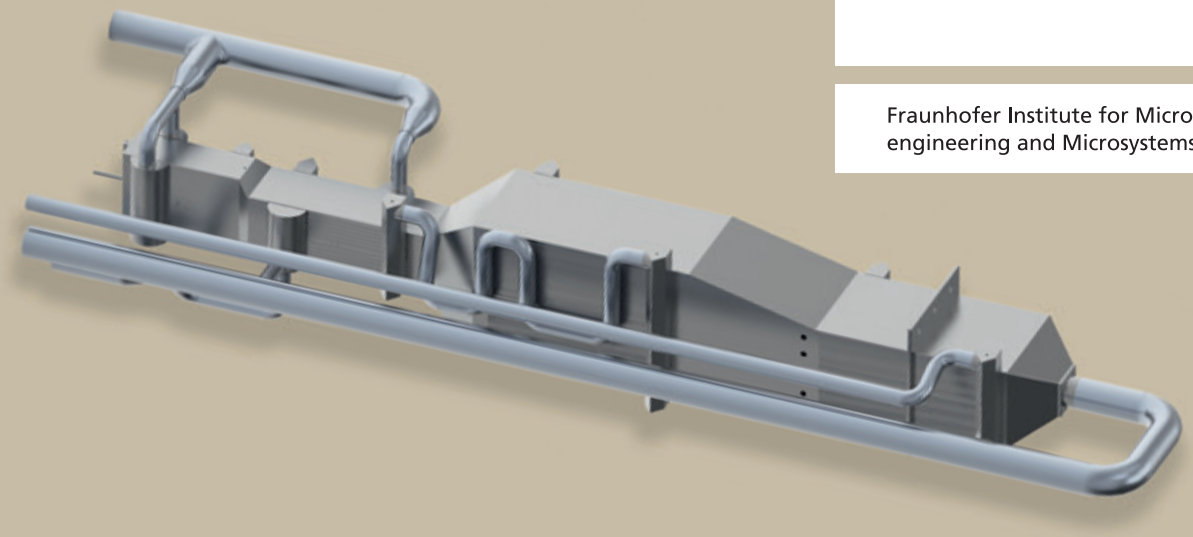
Fraunhofer IMM

Fraunhofer Institute for Microengineering and Microsystems IMM



Ammonia cracker

Hydrogen supply for mobile and stationary applications

Stationary fuel cell applications require compact and sustainable hydrogen supply considering also the still limited availability of compressed or cryogenic hydrogen. For many applications, sustainably produced ammonia is a sustainable hydrogen carrier. But also combustion engines can be supplied with a mixture of hydrogen, nitrogen and unconverted ammonia ("Spaltgas"), while pure ammonia can not be converted in the engines.

The conversion of ammonia to hydrogen (cracking) requires an operating temperature of the reforming process exceeding 450 °C. Fraunhofer IMM ammonia cracker technology is capable of operation temperatures between 450 °C up to 750 °C.

The hydrogen released from the cracked ammonia can then be purified through downstream purification by pressure swing adsorption.

The purified hydrogen can then be fed to a combustion engine or a fuel cell (possible are high and low temperature PEM fuel cells and Solid Oxide Fuel Cells (SOFC) to produce mechanic and/or electric power.

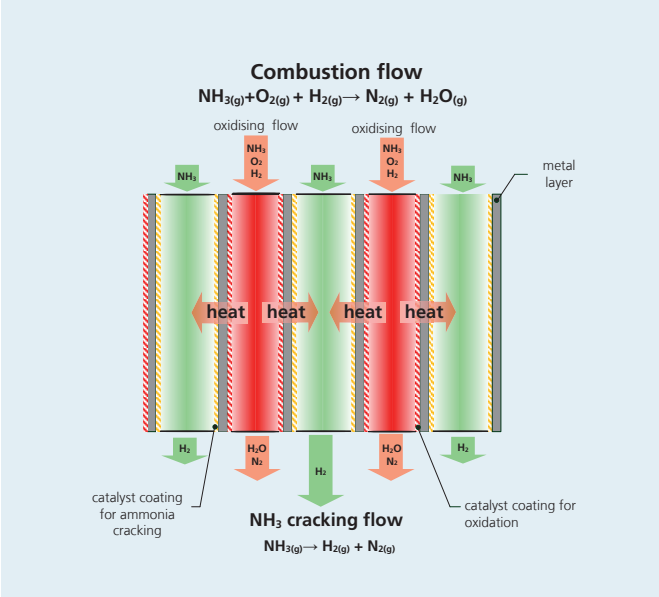
IMM unique ammonia cracking catalyst technology

Benefit from more than 20 years experience in catalyst development for reforming, CO-clean-up and combustion.

IMM has developed a unique catalyst formulation for ammonia cracking which hold the world record in activity.

The catalyst is applied as coating in the reactor, which has a number of advantages especially for mobile applications:

- robust catalyst, no pre-treatment necessary, no performance drop after longer shut-down
- higher activity compared to conventional technology allows minimum catalyst demand (and cost)
- catalyst coating similar to automotive exhaust cleaning avoids catalyst attrition and related pressure drop build-up during operation
- integration into a coated heat-exchanger allows optimum heat management of the endothermic cracking reaction
- conventional (fixed bed) catalyst is not fully utilized and consequently even more catalyst is required compared to coated catalyst



Catalyst coated cracking reactor

IMM has developed a highly compact cracking reactor, which has several advantages compared to conventional technology, which originate from our unique catalyst and reactor technology:

- robust catalyst, no pre-treatment necessary, no performance drop after longer shut-down
- higher activity compared to conventional technology allows minimum catalyst demand (and cost)
- catalyst coating similar to automotive exhaust cleaning.
- reduces catalyst demand further
- plate heat exchanger technology allows optimum heat integration and higher system efficiency of 90 % compared to conventional technology which range around 70 % (fixed bed or electrically heated reactors)

Fraunhofer IMM reactor technology holds second place on the world rank in productivity.

- efficiency gains through the utilization of off-gases of pressure swing adsorption or hot off-gases of combustion engines
- minimum carbon footprint compared to cracking reactors supplied by electricity or external combustion
- reactor fabrication similar to automotive high pressure heat exchangers or fuel cell metallic bipolar plates
- cheap fabrication steps: Embossing, screen printing and laser welding allow cost reduction for product ramp-up

Benefit from more than 20 years experience in catalyst and reactor development for stationary, mobile (aviation, maritime, ground transport) and portable applications.

Apart from the cracking reactor, the ammonia cracking system requires devices for evaporation, and other balance-of-plant.

IMM has developed compact and highly integrated high-performance components for that. The fuel processor design needs to be optimized for your specific application:

- the fuel cell or combustion engine type
- the power range
- the specific environment
- the specific market requirements (achievable price and sales numbers) because fabrication techniques need to be chosen accordingly

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