



## HYBRID MANUFACTURING

Multi-material | Lightweight | Complex Geometry



**Challenge:**  
Achieving Multi-Funcinality



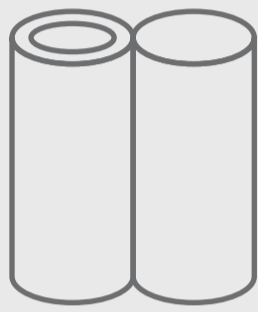
**Alternative:**  
AM Technology



Lightweight, complex geometry multifunctional devices able to operate in harsh environments

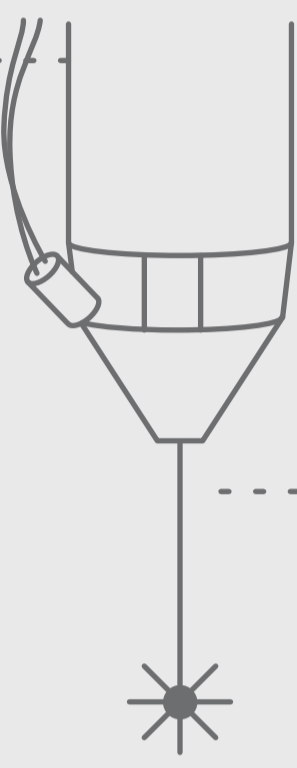
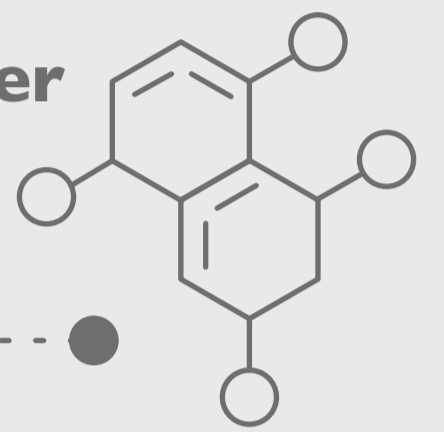
### Metal-Metal

P-DED / LB  
P-DED / PA  
PBF / LB



### Metal-Polymer

W-DED  
POL-DED



### Rocket Engines



### Marine Engines



### Hydrogen Fuel Tanks

- 1 PBF-printing of a rocket engine combustion chamber out of copper.
- 2 Application of an Inconel exoskeleton via powder-based DED.
- 3 Hot fire test performance to confirm the expected impact of engine performance on the structure.

- 1 PBF-printing structures of a marine engine heat exchanger.
- 2 DED Application of a stainless steel heat exchanger outer frame by using the DED process.
- 3 Real marine engine operation test performance by running 200 hours of tests on a full-scale test engine.

- 1 PBF manufacturing of a heat exchanger.
- 2 DED manufacturing of an aluminium liner around the heat exchanger.
- 3 Application of a carbon fibre composite / thermoplastics overwrap on the liner.
- 4 Hydraulic and cryogenic test performance mimicking real hydrogen tank operation.

## Impact



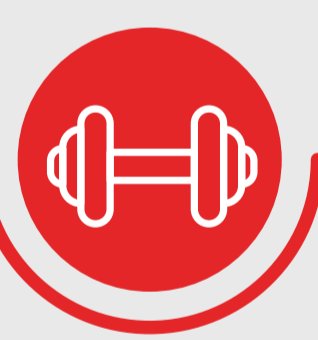
### Improving Process

- Design guidelines for multi-material components
- Material Database
- Material Sustainability Evaluation
- Testing for Qualification of Material Combination
- Surface Treatment Applications Database
- "Recipe Books" Of Individual Process Parameters



### Improving Product

- Series of iterative designs
- Metal-Metal / Metal-Polymer
- Prototyping;
- Use-case 1: Rocket Engines
- Use-case 2: Marine Engine
- Use-case 3: Hydrogen Fuel Tank



### Strengthening the EU Industry

- Dissemination
- Exploitation
- Communication
- Business Plan
- Documentation of novel dissimilar material testing procedures



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