DOMINANT: Development of Hybrid Additive Manufacturing Technologies for Nickel and Niobium Based High Temperature Materials for Aerospace and Energy Application

Abstract:

In this project, Alloyed and RHP will form a European consortium to advance hybrid manufacturing by combining direct energy deposition (DED) and selective laser melting (SLM) processes, raising the technology readiness level from 2 to 5. The project will use two high-performance alloys: ABD1000, a Nickel-based superalloy designed for high AM processability and performance up to 1000 °C, and FS-85, a Niobium-based superalloy with excellent high-temperature strength and creep resistance. The aim is to produce five demonstrators for aerospace and energy applications that will showcase and promote the developed materials and hybrid manufacturing technologies.

Countries involved

Application sectors
Aerospace, Energy

Research and innovation domains
Advanced manufacturing processes

Total cost in M€ (millions)
1.4 M€

Starting date
01/06/2025

Duration (in months)
24 months

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RATIONALE OF THE PROJECT

Over the next two years, Alloyed and RHP will work together to advance additive manufacturing (AM) for high-temperature industrial systems by developing hybrid manufacturing methods that combine Selective Laser Melting (SLM) and Direct Energy Deposition (DED). This approach will address the challenges of producing complex, high-performance components for critical sectors like aerospace, space, and energy, where extreme temperatures and demanding performance requirements are common. The project will focus on optimizing the processing of cutting-edge alloys such as ABD1000—a Nickel-based superalloy with superior AM printability and high-temperature performance—and FS-85, a Niobium-based alloy for cost-effective, high-performance satellite thrusters. By refining SLM and DED parameters, the consortium aims to fabricate demonstration parts that showcase the benefits of hybrid AM, including multi-material flexibility and advanced designs that outperform conventional cast or coated parts. Alongside this, detailed performance data will be generated through extensive testing. The project also aims to boost environmental and resource efficiency by leveraging AM's advantages over traditional manufacturing, supporting next-generation aircraft engines and sustainable energy technologies like nuclear fission and fusion.

TECHNOLOGICAL INNOVATION, ACHIEVEMENTS AND RESULTS

“This project will achieve two main technical goals: extending Alloyed’s proven SLM process to include RHP’s DED process for the advanced ABD1000 and FS-85 alloys, and raising the technology readiness so both methods can reliably produce high-performance parts. By improving hybrid manufacturing, the project will enable the combination of different materials in a single component—ideal for aerospace parts. It will also allow damaged components to be repaired using DED, reducing waste. Using advanced modelling and the design freedom of AM, the project aims to create lightweight, optimized parts with over 50% mass savings and robust heat management. Overall, it targets hybrid-manufactured parts with mechanical properties that can compete with current top nickel superalloys for demanding applications. This project brings major innovation to high-temperature system design and manufacturing for aerospace by: (1) Speeding up product design and delivery by integrating advanced simulations, design, and manufacturing modelling. (2) Cutting manufacturing costs by replacing expensive materials with high-performance, lower-cost alloys like ABD1000 and FS-85. This approach, along with efficient process strategies, reduces build times by up to 77% and can lower costs for propulsion systems by about 250k€. (3) Finally, it disrupts traditional supply chains by enabling more vertically integrated AM production, cutting lead times for complex parts from a year to just 15 weeks.”

MARKET POTENTIAL

For “EU market: Growing turbine market (from $5.67 billion to $7.53 billion by 2031); strong push for clean energy and efficiency. AM adoption is increasing to cut downtime, lower costs, and support sustainable manufacturing in high-temp applications. RHP will expand its additive manufacturing from development to production, targeting aerospace and industrial markets, with expected multi-million euro sales and job growth. Alloyed aims to boost sales of its advanced superalloy components in aerospace and energy, leveraging partnerships and improved technologies to capture market share and diversify revenue.”

IMPACT POTENTIAL

Project DOMINANT aims to tackle the main barriers to using AM superalloys for high-temperature applications by hybrid manufacturing and strengthening Europe’s supply chain. By combining SLM and DED, the project reduces the high costs, waste, and defects of traditional methods like casting and milling, while delivering precise, efficient, and sustainable production. With partners across Europe handling powder production, AM processing, testing, and final use by major aerospace and energy companies, DOMINANT will boost Europe’s competitiveness, enable better material performance, cut environmental impact, and support innovation across sectors like aerospace, energy, and even motorsport.

Material ABD1000			
KPI	SoA	Target	Comments
KPIs for microstructural requirements			
Improve as-printed optical density (XY and XZ directions)	>=99.5 %	>=99.7 %	Improve deposition parameters and find the optimal footprint
SLM as-printed roughness (vertical, upskin, downskin)	>=15 µm	<=7 µm	Evaluated on deposition of test specimens
Reduce the as-printed crack density (XY & XZ directions)	>1 mm/mm²	<0.3 mm/mm²	Improve deposition parameters and find the optimal footprint
KPIs for processing requirements			
DED Feeding rate	-	>2 kg/h	Evaluated on deposition of test specimens
KPIs for mechanical performance requirements			
Yield strength @600°C	>450 MPa	>600 MPa	Evaluated on samples extracted from test specimen components
Tensile strength @600°C	>600 MPa	>800 MPa	
Elongation at break @600°C	>28%	>23%	
Yield strength @1000°C	>145 MPa	>300 MPa	
Tensile strength @1000°C	>180 MPa	>360 MPa	
Elongation at break @1000°C	>28%	>28%	
Creep strain and rupture time @800°C, 200 MPa	<8%, >800h	<8%, >1000h	
Creep strain and rupture time @1000°C, 80 Mpa	<8%, >300h	<8%, >1000h	
KPIs for powder feedstock requirements			
Chemical composition	-	Table 1	Evaluated on samples extracted from test specimen components

Material FS-85			
KPI	SoA	Target	Comments
KPIs for microstructural requirements			
Improve as-printed optical density (XY and XZ directions)	>=99.5 %	>=99.7 %	Improve deposition parameters and find the optimal footprint
SLM as-printed roughness (vertical, upskin, downskin)	>=15 µm	<=7 µm	Evaluated on deposition of test specimens
Reduce the as-printed crack density (XY & XZ directions)	>1 mm/mm²	<0.3 mm/mm²	Improve deposition parameters and find the optimal footprint
KPIs for processing requirements			
DED Feeding rate	-	>2 kg/h	Evaluated on deposition of test specimens
KPIs for mechanical performance requirements			
Yield strength @20°C	>400 MPa	>500 MPa	Evaluated on samples extracted from test specimen components *Lower elongation at much higher strength at 20°C and 1100°C. The loss in ductility is compensated by excellent tensile strength and creep performance **Lower creep strain is better
Tensile strength @20°C	>500 MPa	>700 MPa	
Elongation at break @20°C*	>20%	>8%	
Yield strength @1100°C	>70 MPa	>200 MPa	
Tensile strength @1100°C	>100 MPa	>250 MPa	
Elongation at break @1100°C*	>20%	>15%	
Creep strain at 1300°C, 22 MPa**	<2% strain @1000h	<1% strain @1000h	
KPIs for powder feedstock requirements			
Chemical composition	-	Table 2	Evaluated on samples extracted from test specimen components
Oxygen content in fabricated material	-	<500 ppm	Monitor powder composition to ensure oxygen concentration below target