TECH OFFER

Advancing 3D Printing of Corrosion-Resistant Steels for Harsh Environments

KEY INFORMATION

TECHNOLOGY CATEGORY:
Manufacturing - Additive Manufacturing

TECHNOLOGY READINESS LEVEL (TRL): TRL7
COUNTRY: SINGAPORE
ID NUMBER: TO175468

OVERVIEW

This technology enhances additive manufacturing (AM) of corrosion-resistant Stainless Steel 254 (SS254), a super austenitic alloy engineered for exceptional durability in harsh and saline environments. Developed through collaborative research supported by national innovation funding, the project optimised key AM parameters to achieve consistent part quality and mechanical performance.

Through extensive experimentation, a validated processing window was established to ensure dense microstructure, high mechanical strength, and excellent corrosion resistance. The printed SS254 parts demonstrate a yield strength of approximately 600 MPa and can operate effectively across temperatures from −50 °C to over 250 °C.

This advancement enables the production of complex, high-performance components directly through additive manufacturing, eliminating the need for conventional casting or machining. By positioning SS254 as a cost-effective alternative to nickel and titanium alloys, this innovation promotes sustainable, digital manufacturing for corrosion-critical applications across marine,

chemical processing, and energy sectors.

TECHNOLOGY FEATURES & SPECIFICATIONS

- Material: Super austenitic stainless steel 254 (SS254)
- Corrosion Resistance: Exceptional resistance to chloride-induced corrosion and stress-corrosion cracking, ideal for marine and offshore exposure
- Mechanical Strength: Yield strength ~600 MPa, comparable to nickel-based superalloys
- Temperature Tolerance: Reliable operation from −50°C to 250°C
- Proven Process Charactherisation: Over five parameter combinations tested to establish an optimised, repeatable processing window ensuring >99.5% density and dimensional stability
- Surface Finish & Post-Processing: Capable of achieving improved surface roughness after minimal finishing treatments
- Sustainability: Reduces material wastage, enables digital inventory management, and supports on-demand production of spare parts

This parameter-optimised process enables the production of functional SS254 components that meet or exceed international standards (API, ISO) for high-strength, corrosion-resistant materials.

POTENTIAL APPLICATIONS

The optimised 3D printing process for SS254 opens new opportunities for marine, oil & gas, and offshore engineering sectors that demand durable, corrosion-resistant parts. The technology also supports digital spare-part libraries, enabling remote, on-demand production for maintenance and repair operations (MRO). By reducing logistics dependency and lead time, it supports supply chain resilience in industries operating in remote or high-risk environments.

Potential applications include:

- Subsea and offshore structures such as pump housings, valves, and connector flanges
- Ship components exposed to seawater, including propeller hubs, brackets, and supports
- Oilfield and drilling equipment requiring high mechanical integrity and corrosion resistance
- Heat exchangers and cooling systems in chemical or desalination plants

MARKET TRENDS & OPPORTUNITIES

Global demand for corrosion-resistant alloys is steadily increasing across marine, offshore, and energy sectors, driven by the pursuit of longer-lasting and more cost-efficient solutions. The rapidly growing metal additive manufacturing market further enhances these opportunities by enabling decentralised production, faster turnaround times, and reduced inventory costs.

This technology offers strong commercial appeal to companies aiming to replace costly nickel or titanium alloys with SS254, achieving comparable mechanical and corrosion performance at a significantly lower material cost. In Singapore and the wider Asia-Pacific region, the innovation aligns with ongoing maritime decarbonisation and sustainability goals, supporting the transition toward localised, digital manufacturing ecosystems within shipyards and maintenance facilities.

As industries continue to embrace sustainable and digital production models, this SS254 additive manufacturing process presents substantial market potential for both original equipment manufacturers (OEMs) and aftermarket service providers seeking durable, corrosion-resistant metal solutions.

UNIQUE VALUE PROPOSITION

By integrating this technology, industries can digitise spare-part inventories, implement on-demand manufacturing, and strengthen supply chain resilience in corrosion-prone sectors.

- **Cost-effective alternative to nickel and titanium:** SS254 uniquely combines high corrosion resistance, mechanical strength, and print reliability.
- **Support fabrication of intricate designs:** Additive manufacturing process enables the fabrication of complex geometries without tooling, reducing material waste and lead time. The validated process window ensures consistent part quality and repeatability — critical for industrial adoption.