PUBLIC TECHNICAL INFORMATION

Laser Metal Deposition for Industrial Parts

Process selection, project inputs and qualification planning

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Purpose and boundary

This document supports an initial technical discussion about Laser Metal Deposition (LMD), laser cladding and related process choices. It does not approve a component, material, repair, coating or inspection plan. Feasibility depends on the actual part, substrate, geometry, access, finishing route and acceptance criteria.

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Document control

Revision	Date	Change
1.0	4 July 2026	Initial technical introduction.
1.1	14 July 2026	Added document control and references; aligned terminology and public capability wording.
2.0	15 July 2026	Interim website-publication layout.
2.1	15 July 2026	Reworked as a restrained technical report; removed editorial imagery and QR codes; applied the supplied company logo; added direct Exafuse resource links.

Reading note

The guide provides general process-selection context. Equipment figures and published examples describe a technical envelope or a specific project; they are not automatic promises for another component.

Contents

1 Scope and intended use

Laser Metal Deposition is suitable for evaluation when the task requires local material addition: building a larger near-net-shape part, restoring a worn or undersized region, adding a feature, or applying a metallurgically bonded functional layer. It is less suitable when the main requirement is fine powder-bed detail across a compact part, when the deposition zone cannot be reached and finished, or when the substrate and acceptance requirements are unknown.

The technical question is not only whether a laser can deposit a particular alloy. The relevant question is whether deposition, heat management, machining or grinding, inspection and documentation form a workable process chain for the component.

Minimum useful input for an initial review

Part goal, drawing or CAD data, dimensions and approximate mass, base material, affected zone, functional surfaces, finishing requirements, quantity, deadline and expected inspection evidence.

2 Terminology

ISO/ASTM 52900 establishes the general vocabulary for additive manufacturing. The standard defines process families; it does not qualify an individual machine, material or component. The current edition is ISO/ASTM 52900:2021, confirmed by ISO in 2025 [1].

Term	Meaning in this guide	Typical decision context
DED	Directed Energy Deposition, the wider process family	Additive material is deposited while focused energy melts it
DED-LB/M	Laser-beam DED using metallic feedstock	Standards-oriented description of laser-based metal deposition
LMD	Laser Metal Deposition	Common industrial term for laser-based, powder-fed deposition
Laser cladding	LMD used primarily to create a functional surface layer	Wear, corrosion, oxidation or local surface function
SLM / LPBF	Laser Powder Bed Fusion	Compact new parts whose value lies in fine detail or internal geometry
Additive–subtractive process chain	Additive deposition followed by machining, grinding or another subtractive step	Final dimensions and functional surfaces

In German industrial use, *Laserauftragsschweißen* is the corresponding process term. “Hybrid” should always state the combination intended. In this guide it means an additive–subtractive process chain, not a generic label for every project using more than one manufacturing method.

3 Powder-fed LMD process principles

A laser creates a controlled melt pool on a metal substrate or on a previously deposited layer. Carrier gas transports metal powder through the deposition head into that melt pool. As the head or part moves, the molten material solidifies into a track. Adjacent tracks and successive layers form a coating, repair volume, local feature or near-net-shape component. NIST describes DED as a layer-wise process in which a nozzle deposits material onto a target and a directed energy beam melts it [2].

Track geometry and metallurgical response are influenced by interacting variables, including:

- laser power distribution, spot size and travel speed;
- powder delivery, carrier gas, shielding and nozzle stand-off;
- substrate composition, surface condition and thermal mass;
- toolpath, overlap, layer strategy and deposition orientation;
- preheating, interpass temperature and cooling conditions; and
- the required machining allowance, surface condition and inspection plan.

These variables form a project-specific process window. This public guide intentionally does not provide transferable parameter recipes or present equipment limits as guaranteed component results.

4 Manufacturing-route comparison

Decision point	LMD / DED-LB/M	SLM / LPBF	Conventional or combined route
Main technical role	Local material addition, repair, cladding or larger build volume	Compact detail, internal channels or powder-bed-native geometry	Standard geometry, high volume, very thin coating or an established repair method
Existing component	Often present for repair, modification or cladding	Normally a new build on a platform	Depends on machining, welding, coating or replacement route
Surface condition	Functional surfaces commonly require later finishing	As-built detail is finer, but finishing may still be required	Depends on the selected process
Main uncertainty	Access, heat input, dilution, finishing and inspection	Orientation, supports, powder removal, stress and inspection	Tooling, material removal, joining, coating adhesion or lead time

LMD merits evaluation when scale, local build-up, repair or a metallurgically bonded layer creates the technical benefit. SLM / LPBF merits evaluation when compact detail or internal geometry is the principal requirement. Another route should be considered when the part is standard, access is poor, heat input is unacceptable, or a credible qualification route cannot be defined.

5 Application-specific considerations

5.1 New part or local feature

Start with CAD, envelope, mass, material, functional surfaces, quantity and machining allowance. A complete LMD build needs a toolpath and support strategy that account for heat accumulation and finishing access. A local feature on an existing component additionally needs a defined interface and confirmed substrate.

5.2 Repair or dimensional restoration

Repair feasibility depends on damage location and cause, remaining sound substrate, previous repair history, access, target geometry and acceptance criteria. Unknown material condition, systemic cracking or inaccessible damage can make replacement the more defensible decision.

5.3 Laser cladding

Material selection begins with the failure mechanism and operating environment, not hardness alone. Inputs include the substrate, wear or corrosion mode, counter-surface, medium, temperature, coating zone and finishing method. Dilution, crack sensitivity and heat-affected-zone behaviour must be evaluated for the material pairing.

6 Materials and qualification

Fe-, Ni- and Co-based alloy families, copper-alloy routes and carbide-containing systems can all be relevant to LMD work. A family name does not establish availability, compatibility or qualification for a particular substrate. Material selection must consider:

- substrate composition and condition;
- dilution and the resulting chemistry at the interface;
- thermal expansion, phase formation and crack sensitivity;
- required toughness, wear, corrosion or temperature behaviour;
- machinability or grindability after deposition; and
- the physical evidence required for acceptance.

Where the material combination or acceptance route is new, test tracks, walls or representative coupons may be needed before component work. Coupon evidence must still be related carefully to component geometry and thermal history.

7 Quality, inspection and monitoring

Quality planning starts before deposition. Depending on part function and risk, the agreed evidence may include dimensional inspection, visual or surface testing, non-destructive examination, metallographic cross-sections, microscopy or other project-specific checks. These methods answer different questions and should be selected around plausible failure modes.

Process monitoring can support process understanding, traceability and review of unusual regions. It does not by itself establish final part quality. NIST's 2024 review of in-process monitoring and non-destructive evaluation identifies continuing knowledge, technology and standards gaps before monitoring can be treated as a robust part-qualification tool [3].

Acceptance principle

Monitoring, physical inspection and destructive or metallographic evidence are complementary. The project should define what is measured, what each method can show, the acceptance criteria and who is responsible for release.

8 Public Exafuse capability context

The following figures describe the public equipment envelope listed by Exafuse. They are not automatic promises for a particular geometry, tolerance, material, deposition rate or finished surface [4, 5].

Process route	Public technical context
CNC-based LMD	4 m^3 build-space context; component window up to 2 m $\times$ 1 m $\times$ 2 m; published wall-width context of 1.8–3.7 mm
Robotic LMD	Six-axis robot with additional positioning; 6 m $\times$ 5 m $\times$ 4 m installation-space context; rotary-table support up to 1,000 kg; published wall-width context of 1.5–4.5 mm
SLM / LPBF	TRUMPF TruPrint 3000; 400 mm platform diameter, 400 mm build height and 500 W single-laser configuration
Supporting process chain	Milling, grinding, sandblasting, plasma cutting and heat-treatment equipment; microscopy and metallographic preparation for inspection discussions

Final suitability is confirmed only after reviewing the actual component, fixturing, deposition access, material, finishing and inspection requirements.

9 Information for a feasibility review

Project type	Minimum useful information
New LMD build	CAD or drawing, envelope, mass, material, quantity, functional surfaces, machining allowance, deadline and inspection expectation
Repair or modification	Photos with scale, nominal geometry, measured damage or undersize, base material, damage history, target geometry, access and acceptance criteria
Laser cladding	Substrate, failure mechanism, operating medium and temperature, coating zone, target property, final surface and inspection expectation
SLM / LPBF part	CAD, envelope, material, internal features, powder-removal access, critical surfaces, quantity and post-processing needs

An initial discussion can begin with non-confidential dimensions, a material family and redacted images. Detailed files should follow through a transfer method agreed for the project. Website tools provide an initial direction only and do not create a quotation or approve feasibility.

10 Related Exafuse resources

The following pages provide current service descriptions, project examples and technical guidance. Each link opens the corresponding page on exafuse.de.

Link	Use
Technology and equipment	Published process and equipment envelope for LMD, SLM / LPBF and additive–subtractive routes
Metal additive manufacturing	Process-selection context for new-build LMD, SLM / LPBF and combined manufacturing routes
Repair and modification	Technical inputs, limits and process-chain questions for repair work
Laser cladding	Surface-function, material-selection and validation context
Quality and inspection	Inspection, monitoring and acceptance-planning context
750 mm multi-material nozzle case	Published thin-wall and material-zoning demonstrator
Inconel 718 thin-wall case	Published demonstrator for wall continuity, finishing and validation boundaries
Failure modes and cladding solutions	Wear-mechanism, coating and inspection decision context
RFQ guide for LMD repair and cladding	Checklist for drawings, material, acceptance criteria, timing and documentation
Contact and feasibility request	Technical enquiry and project-start information

References

[1] ISO, *ISO/ASTM 52900:2021, Additive manufacturing — General principles — Fundamentals and vocabulary*, Edition 2, confirmed 2025. https://www.iso.org/standard/74514.html

[2] National Institute of Standards and Technology, *Directed Energy Deposition*, updated 16 May 2025. https://www.nist.gov/additive-manufacturing/research-areas/technologies/directed-energy-deposition

[3] A. Donmez et al., *In-process monitoring and non-destructive evaluation for metal additive manufacturing processes*, NISTIR 8538, 2024. https://doi.org/10.6028/NIST.IR.8538

[4] Exafuse, *LMD, SLM and Hybrid Technology*, accessed 15 July 2026. https://exafuse.de/en/technology/

[5] Exafuse, *Metal AM: LMD, SLM and Hybrid Routes*, accessed 15 July 2026. https://exafuse.de/en/services/metal-additive-manufacturing/

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