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Article 2: Laser Cladding Has Many Faces

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In my previous article, I have tried to define an "Introduction to Laser Cladding Technology" and what are the main advantages of the process. Today, I would like to speak about abbreviations related to laser cladding technology. Everybody has seen in literature or heard during dialogues with customers, experts or colleagues terms like — DED, LMD, EHLA, etc. Some of you are familiar with all of them but for some of us it might sound a little confusing. So let's take a look together and try to understand what is hidden behind these acronyms.

Do we speak about the same process?
I work for a global company where not everybody is familiar with the technology and also many of our customers have no idea about laser cladding. Therefore, communication internally and externally on different levels of technical involvement is part of the daily routine for me and my team. It commonly happens that people can speak about the same technology but use different terms or designations. Honestly it often makes me smile to realize how many different abbreviations and explanations people might use for the same process.

To simplify the whole explanation I have put together a list of designations that all mean more or less the same process — laser cladding. Some of you may disagree with me, trying to explain the details but the principles of laser cladding and process names shown in Figure 1 are very similar and the technology of direct interaction of filler material (powder or wire) with a laser beam by building a layer of material on the surface of a substrate stays the same. That is what matters the most.

Why make technical things even more complicated? I think quite often it is better to stop confusing each other and keep everything simple. After all, we all want to be understood. So let's have a closer look at the list and try to understand together what is different. With a simple google search I have found the descriptions of abbreviations and listed their explanations below. All the links to references are placed as notes.

Laser Cladding (LC) is the most commonly used definition and you can find many term descriptions on the Web. I have taken one from an Oerlikon Metco web page, where it says, “Laser Cladding is a weld build-up process and a complementing coating technology to thermal spray. In laser cladding, the laser beam is de-focused on the workpiece with a selected spot size. The powder coating material is carried by an inert gas through a powder nozzle into the melt pool. The laser optics and powder nozzle are moved across the workpiece surface to deposit single tracks, complete layers or even high-volume build-ups.” [a]

Direct Metal Deposition (DMD) might not be related to laser as an energy source but it is still a method of hardfacing by welding. Quite commonly, if related to a laser, it transforms into an LDMD (Laser Direct Metal Deposition) or to LMD (Laser Metal Deposition). My friends from Inspire use that term on their web page [b]. The only difference to conventional laser cladding is the 3D dimensional part treatment. “…While the classic laser cladding process is a two-dimensional coating process, laser DMD is a three-dimensional process that can be used to apply a large amount of material within a short period of time.”

It would be possible to start a discussion here and remind us that, for example, 3D-dimensional laser cladding restoration for applications such as turbine blades was introduced already during the 80s to 90s of the 20th century. Then, no one was even speaking of the term additive manufacturing. However, it is more important to note that there are no technical differences for the process — same laser source, same or similar working heads and nozzles are used. The cladding strategy would be slightly different today but it is not that you cannot realize a similar result with a standard laser cladding system.

Direct Laser Deposition (DLD) and Direct Energy Deposition (DED)
Searching for this term, I have ended up with a scientific paper available on ScienceDirect [c]. You will love it! Authors are very clear in terms of explanations as to what they mean by their abbreviations, “Laser-based additive manufacturing (LBAM) processes can be utilized to generate functional parts (or prototypes) from the ground-up via layer-wise cladding – providing an opportunity to generate complex-shaped, functionally graded or custom-tailored parts that can be utilized for a variety of engineering applications. Directed Energy Deposition (DED), utilizes a concentrated heat source, which may be a laser or electron beam, with in situ delivery of powder- or wire-shaped material for subsequent melting to accomplish layer-by-layer part fabrication or single-to-multi layer cladding/repair. Direct Laser Deposition (DLD), a form of DED…” So DLD is a form of DED by defined source and that’s the same as LMD and LC!

Figure 1: Do we speak about similar processes and technologies?

Laser Powder Deposition (LPD) an exotic abbreviation. Its explanation I could find only at a limited number of sources. Here is one of them taken from a company RMP Innovation [d], where it says: “LPD is a technique utilizing a focused laser beam to fuse metal/ceramic powder to a previously existing metal substrate.” Interestingly, if you click from the first page on their referral link to one of their companies you can find out, that LPD is transformed to LDT [e] (Laser Deposition Technology): “LDT is a process in which metal powder is injected into the focused beam of a high-power laser under tightly controlled atmospheric conditions. The focused laser beam melts the surface of the target material and generates a small molten pool of base material. In the end, authors do confirm that LDT is a blanket name that encompasses many “like” processes — DED, LMD…LC.

Laser Powder Welding (LPW) or Laser Powder Build-Up Welding. That’s how my colleagues from Sulzer in the Netherlands have named the process back in 2001 [f]. Even then, they had spoken about the 3D-dimensional repair (is that not an LMD term?!) and reproduction of single-crystal structures as a key benefit.

Laser Powder Fusion Welding (LPFW) or (LPW) according to the explanation in a book, “Power Plant Life Management and Performance Improvement” [g] or “alternatively laser cladding, utilizes a laser heat source and powder metallurgy technology to actively repair and rejuvenate the component”. I think this quote is self-explanatory.

EHLA - High-speed Laser Cladding. This is a newly developed method also known as EHLA (Extreme High-speed Laser Application). My colleagues at Fraunhofer ILT [h] have published many works related to the EHLA process. It is still a laser cladding process but the unique idea of the process is that you melt the powder before it interacts with the surface where over 80 % of laser energy goes into melting the powder (Figure 2). This allows for the production of thin coatings with low surface roughness and excellent properties, minimized heat input and the processing of entirely new material pairings (like cast-iron substrates). The difference between LC and EHLA is more process principle related, wheres more or less the same equipment can be still used.

In the end, I would like to say that no matter what we call the process, it is more important that we can communicate and understand each other. I will be happy to see more abbreviations (if you know some), referring to the same technology in the comments! Let's make laser cladding more visible together! ■■■

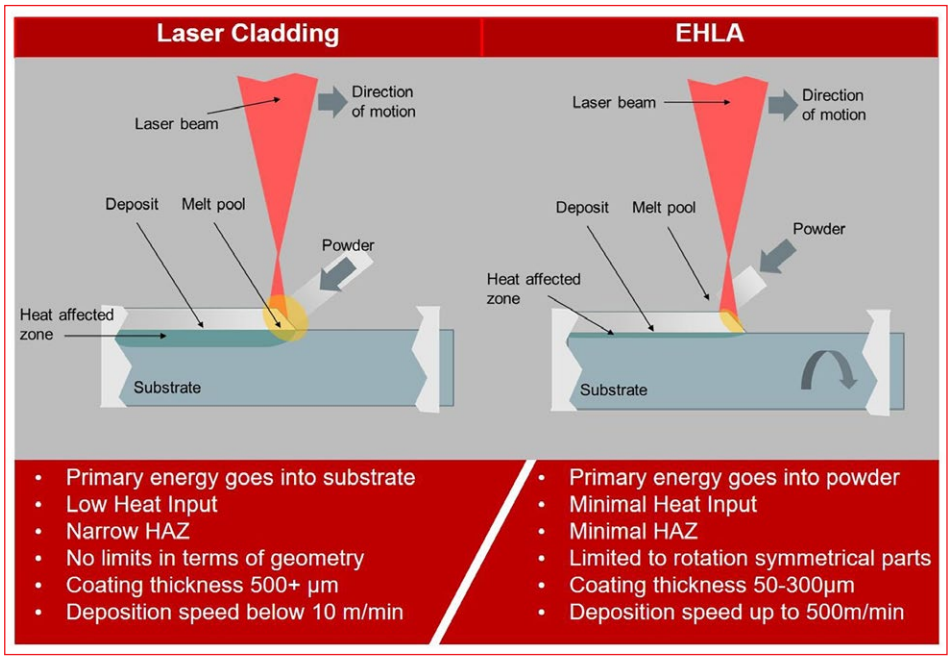

Figure 2: Laser Cladding vs EHLA

References

[a] https://www.oerlikon.com/metco/de/produkte-services/beschichtungsservices/laser-cladding-services/
[b] https://www.inspire.ethz.ch/en/research-for-the-industry/additive-manufacturing-3d-print-design-for-am/metal/
[c] https://www.sciencedirect.com/science/article/pii/S2214860415000317
[d] https://www.sdsmt.edu/Research/Research-Laboratories/AMP/Capabilities/Laser-Powder-Deposition/
[e] https://www.rpmandassociates.com/laser-deposition-technology
[f] https://www.sulzer.com/-/media/files/services/rotating-equipment-services/gas-turbine-services/technical-articles/2001_04_4_krause_e.ashx?la=en
[g] https://books.google.ch/books?id=MHxwAgAAQBAJ&pg=PA430&lpg=PA430&dq=laser+powder+fusion+welding&source=bl&ots=Oli4jjbngE&sig=ACfU3U3O_g-g-91HFWvDVvg_WsvHkuno0Q&hl=de&sa=X&ved=2ahUKEwjcxoKSwMDpAhUI6qQKHbQgDxY4ChDoATADegQICRAB#v=onepage&q=laser%20powder%20fusion%2welding&f=false
[h] https://www.ilt.fraunhofer.de/en/media-center/brochures/brochure-ehla-2017.html

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