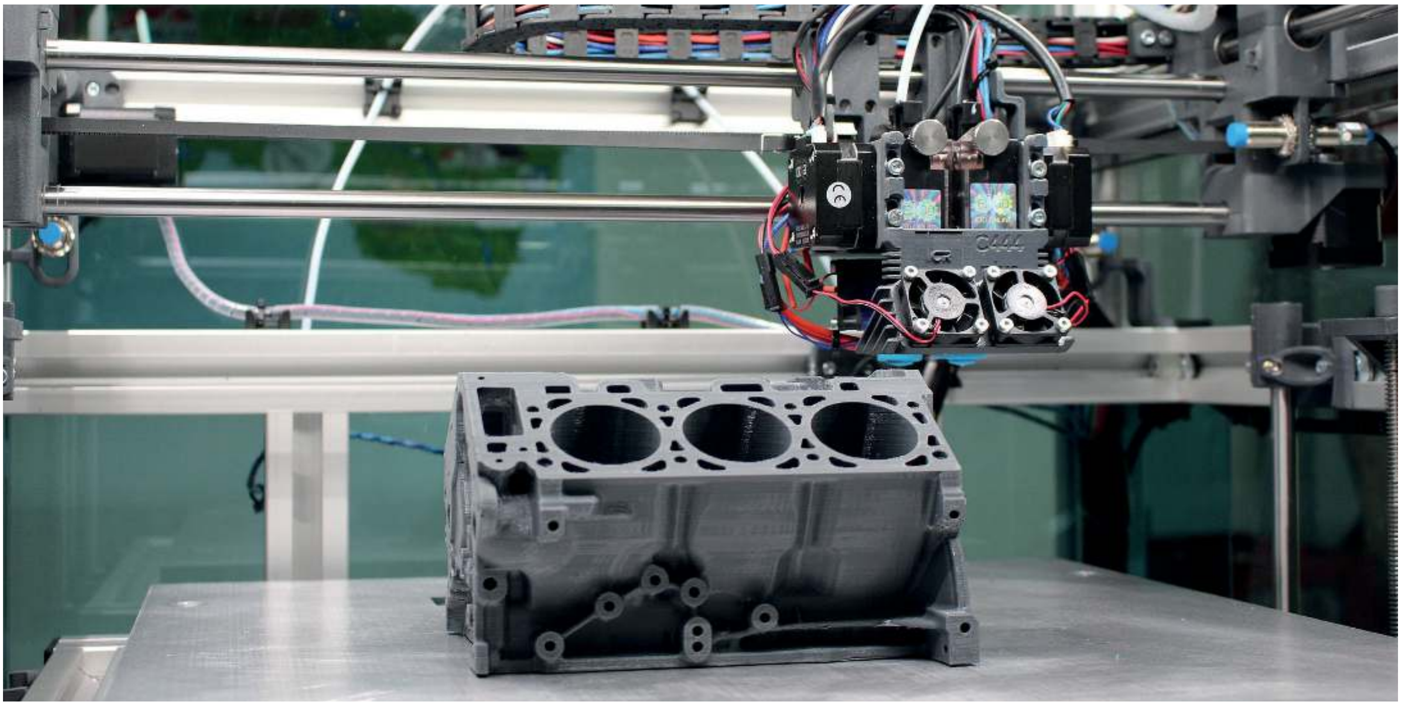
LASER ADDITIVE MANUFACTURING.

Additive manufacturing (AM) refers to a process by which digital 3D design data is used to build-up a component in layers by depositing material.

Companies in Aerospace, Automotive, Medical or even consumers goods, start realizing the added value of additive manufacturing, that are mainly addressing the cost (and time) of manufacturing low volume parts, accelerating the product development time, or giving the pos¬sibility to produce very complex parts. Additive manufacturing could also be used to enhance the performances of parts made by traditional subtractive manufacturing.

For instance, Aeronautic companies may use additive manufacturing for getting lighter parts without sacrificing the robustness.



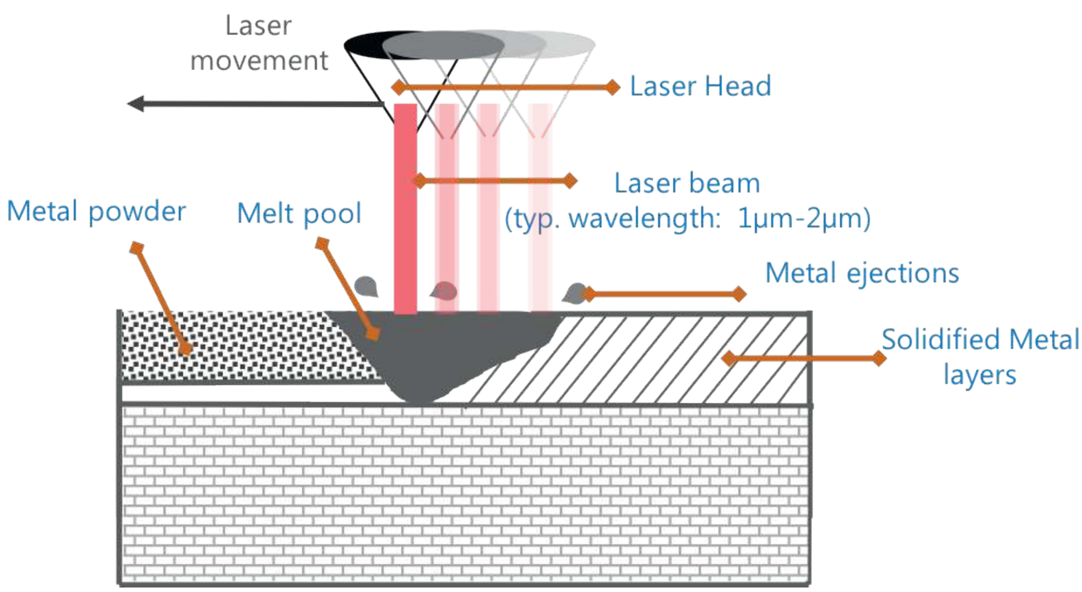
Several processes exist in the additive manufacturing. The most familiar are:

- Fused filament fabrication (FFF/FDM)
- Stereolithography (SLA)
- Selective Laser Sintering/Melting (SLS/SLM) (or known as "Powder Bed Fusion")
- Laser Metal deposition (LMD) / direct Energy Deposition (DED)

OPERATION PRINCIPLE
SELECTIVE LASER MELTING - SLM

Selective Laser Melting (SLM) and **Laser Metal Deposition (LMD)** are getting the “hype”, sprea¬-ding in lot of industries, especially in the aerospace. The main reason is its singularity to do ad¬ditive manufacturing of metals.

In SLM process, a laser is focused and scans a powder bed inducing the metal melting for one layer. The powder is then spread again for next layers. Laser Metal deposition is very similar to SLM but the powder is directly diffused from the laser head to the surface while being heated by the laser spot.



SLM & **LMD** are very complex processes compared to more common 3D printing technics like Fused Filament Fabrication (FFF). Critical parameters are laser power, laser pattern, bed tempe-rature, uniformity and thickness of the layers. Thus, understanding and controlling the physics of the melt pool formation is absolutely a key point to optimize the process.

WiDy SWIR FAMILY IN ADDITIVE MANUFACTURING

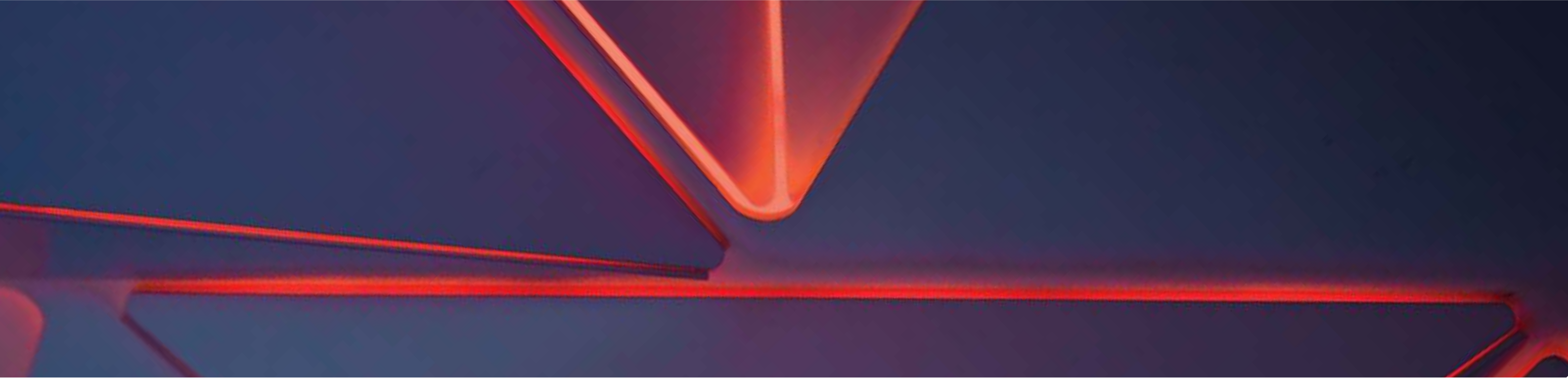
SWIR, THE ALLY OF LASER ADDITIVE MANUFACTURING PROCESSES;

One of the main components of any SLM or DED process is the power source, the laser. The laser source is responsible for transferring the energy to the powder, causing the temperature elevation required for melting the metal powder.

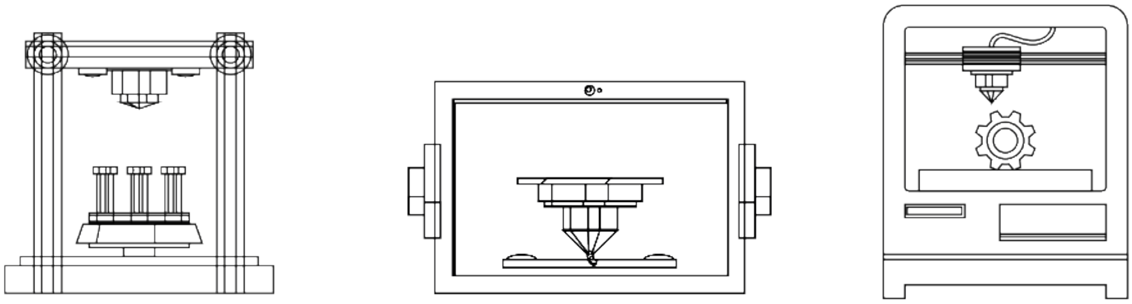
When dealing with metals, in the Aerospace or Automotive industry, the laser wavelength has to be carefully selected in a region where the metal absorption level is at its maximum. Common metals materials, such as Aluminum, copper, chromium, Iron, Nickel, Tungsten or even platinum have their maximum absorption in a wavelength region between 1-2 µm (contrary to polymer where the maximum absorption wavelength is above 10µm): a wavelength band well covered by NIT WiDy SWIR camera.

The NIT SWIR Cameras offer a typical InGaAs response with a covered bandwidth between 900nm-1.7µm. A typical Nd: YAG Laser @ 1064nm, used in many Laser Deposition Processes, will be clearly captured by any NIT WiDy cameras.

A camera with the appropriate wavelength, will give the operator the ability to clearly optimize the fabrications processes – Besides, real-time analysis or post processing could be used to optimize the manufacturing and to increase the overall productivity.



MELTPOOL,
WHERE THE ACTION HAPPENS.



Whether it is on the bed powder, or with a powder deposed, the Meltpool caused by the laser source is the heart of SLS/DED processes.

The physics reactions occurring in the Meltpool will define how good will be the manufacturing. Passing from an un-melted powder to a fully dense solid metal in a very short time (e.g: Speed of typical SLM could be from between 1m/s to 10m/s. This is much faster compared to a traditional welding manufacturing process where speed is in the range of 2m/min) will imply a significant energy transfer on a very small area <mm^2.

This Energy density, with the high-speed scanning rate, leads to a rapid heating, melting, followed by a shrinkage, causing a significant temperature gradient that could be up to 1 000 000°C / sec. As a consequence, the melt pool geometry and shape will influence the grain, growth and the microstructure of the part. Residual stress and deformation may find their birth in an un-proper "meltpool".

THE WiDy SWIR GIVES THE ABILITY TO BRING AN EXTRA EYE ON THE MELTPOOL

Most of existing additive laser manufacturing technics and machine rely on the understanding of all the physics involved to optimize the process results.
However, having additional "imaging" information or analysis on the meltpool during the operation may lead to a really valuable information for process optimization and in-line quality control.

Thanks to its High Dynamic Range in the SWIR band and its fast frame rate with ROI, the WiDy SenS camera is able to acquire all relevant information's of the Meltpool: the true shape and geometry of the Meltpool without blooming effect, the temperature gradient and flow dynamics giving key information on the transformation reactions, and even visualization of the 'sparks' ejection (hot droplets) in the surface responsible also for defects in the structure.

Taking the speed with high frame rate in windowing mode for such a high-speed processing, is also a benefit of the WiDy SWIR family.

For a seamless integration with new additive manufacturing machinery, the WiDy SenS sent out the live data through CameraLink Interface. A Real time analysis or post processing analysis are easily possible thanks to its standard protocol interface and adequate Images processing.

THE 5 REASONS WHY...

To summarize why the WiDY SWIR camera is the perfect allied for Additive manufacturing analysis, control and process optimization, we end our episode with the "5 reasons why" list below:

1. WiDy SWIR spectral band offers response in the 900nm-1.7µm where most of the laser used in SLS/SLM/LMD/DED are.
2. The unique HDR capability in the SWIR band gives clear images of the Melt-pool thermal energy and a visual definition of the Temperature gradient.
3. The WiDy SWIR can operate up to Several Hundred Frame/sec in windowing mode (e.g: 128 x 128 fps) making possible the capture of fast additive manufacturing processes without losing the details of ejected droplet around the melt-pools.
4. The WiDy SWIR antiblooming native function allows a sharp visualization of the Melt-pool shape and geometry without false measurement.
5. The CameraLink standard interface of the WiDy SWIR can easily be integrated into additive manufacturing machinery