METAMORPHA newsletter Apr-2023 (#1)

Made-to-measure micromachining with laser beams tailored in amplitude and phase

Welcome to the first METAMORPHA project newsletter!

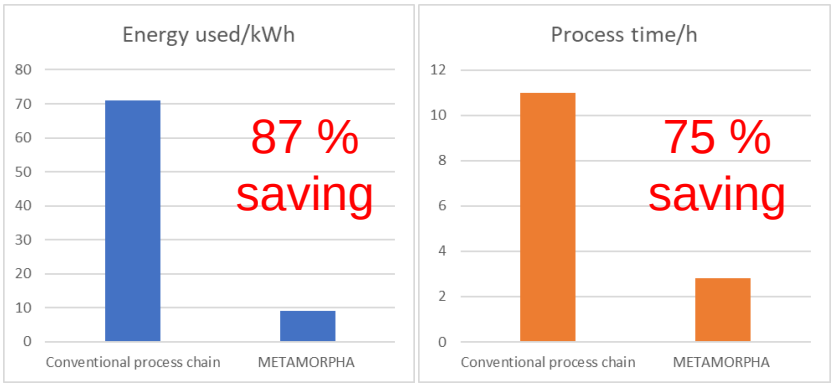
Although we are only six months into this four year project, we already have some great results to present. In this newsletter we have info on:

- First processing results on Ceratizit carbide punches at ILT
- Optics design update from RWTH
- Sustainability and circularity aspects of the project from Arditec
- High resolution scanning technology from DATAPIXEL.

More information is available on the project website https://metamorpha.eu

Photonic process for carbide facet fabrication

One of the three project use cases is the machining of carbide punches used for embossing applications. Conventional manufacturing relies on a process known as electrical discharge machining (EDM). Due to the extremely hard nature of the material, fabrication of a single punch takes 11 h and uses a huge amount of electrical energy. Several other cleaning and polishing steps are necessary, which require the use of various environmentally damaging chemicals.



Initial results of METAMORPHA carbide punch production

METAMORPHA aims to replace this process chain with a single laser-based machining work-station with greatly reduced energy use and process time with no need for damaging chemicals. As shown in the graph opposite, initial trials have already shown remarkable improvements, and these will be further developed during the course of the project.

Consortium

Fraunhofer ILT, LASEA, RWTH Aachen University, fentISS, DATAPIXEL, ARDITEC, VIVID COMPONENTS, Universitat Politècnica de València, CERATIZIT, PHILIPS, thyssenkrupp

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Funded by the European Union

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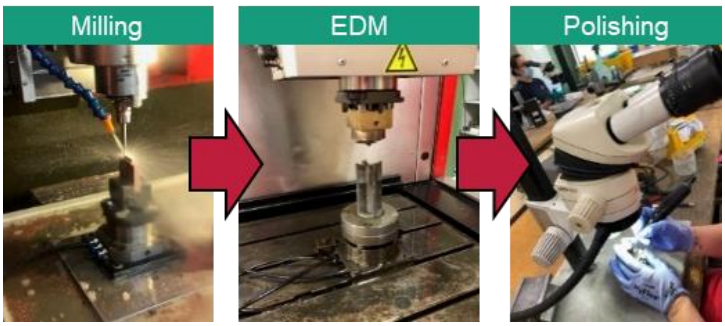

Above: Conventional process chain for carbide punch manufacture requiring three workstations and high energy use. Below: Photonic process chain is performed far more quickly and efficiently on a single laser-based workstation.

Left: Raw punch before polishing process Right: Laser machined punch after laser manufacture and polishing processes.

For more info, please contact:
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Optics design for METAMORPHA micro-machining system

Fraunhofer ILT RWTH AACHEN UNIVERSITY

RWTH working with ILT have developed a suitable optical design for the demanding METAMORPHA application. In addition to the two water-cooled spatial light modulators and galvo scanner, this involves several optical elements after the beam expander, including:

- Half wave plate to adjust the linear polarization
- Quarter wave plate to generate circular polarization
- Integration of camera-based beam diagnostics
- Compatible with F-Theta lenses with various focal lengths.

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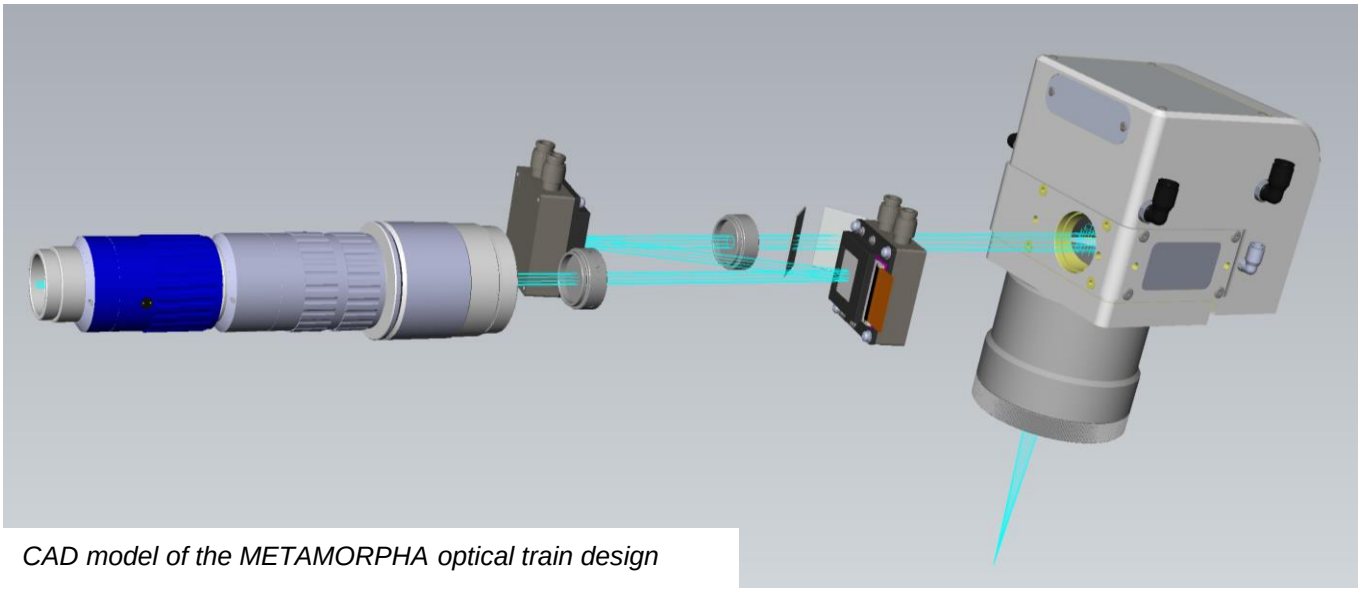


CAD model of the METAMORPHA optical train design

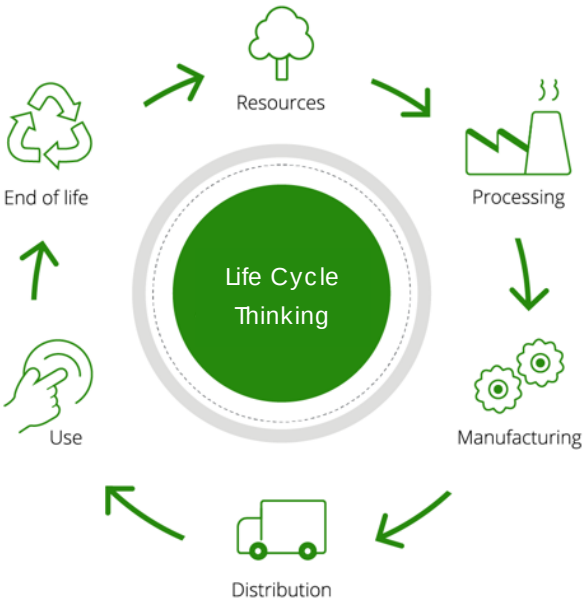
Funded by the European Union

Quantified sustainability studies in METAMORPHA

INTRODUCTION

Within the framework of METAMORPHA, the ARDITEC Association aims to promote sustainable development and social responsibility and protect EU environmental and cultural heritage. The association is currently leading the sustainability assessments by using different standardised methodologies:

- Techno-Economic Assessment (TEA)
- Life Cycle Assessment (ISO 14040/14044)
- Life Cycle Costing (ISO, 2006)
- Social Life Cycle Assessment (UNEP/SETAC).



The objective is to quantify the environmental, economic and social benefits of the METAMORPHA technology implementation in the value chains relating to the three use cases (PHILIPS, THYSSENKRUPP, CERATIZIT); see pg 4-5.

An initial assessment is being conducted on the current production chain of the end-users in order to quantify the sustainable benefits later in the project.

WHAT HAS BEEN DONE

Requirements definition: Together with the technical partners, ARDITEC made an exhaustive list of sustainable considerations that will be assessed later in the project. The objective of this task early in the project is to highlight partners' main concerns about sustainability for their current technologies but also how they will take advantage of the METAMORPHA laser optical module and its applications.

Sustainable assessment: In parallel, ARDITEC worked on the first step of the sustainable assessments which is common to all the studies (TEA/LCA/LCC/SLCA), namely the goal and scope definitions system, the goal of the study, benchmarking, functional units, the value chain under assessment, literature review of similar studies *etc.*

The main objective of these meetings was to understand each process, highlight potential hotspots, present the specific template elaborated by ARDITEC for data collection and align the sustainable approach to the own sustainability strategy of the end-user.

NEXT ACTIONS

For the coming months, ARDITEC will focus its efforts on the data collection for the three use cases, organizing follow-up meetings with PHILIPS, THYSSENKRUPP and CERATIZIT. The objective will be to gather environmental and economic data to start the environmental assessment of the baseline scenarios on the one hand, and to model the techno-economic assessment on the other.

We invite all stakeholders to visit the website for more details on the sustainability studies and to follow our social media channels.

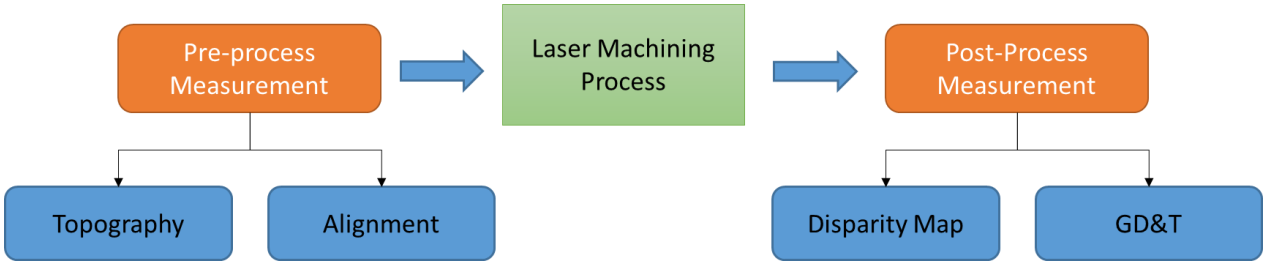
For more info, please contact: jose.gallego@arditec.net

High resolution 3D scanning in METAMORPHA

With >20 years of experience in 3D machine vision and metrology, DATAPIXEL is participating in METAMORPHA as an expert in designing, implementing and integrating 3D scanning optical sensors and software for high accuracy dimensional control.

METAMORPHA proposes an innovative approach to USP laser machining by adapting the process and parameters to the specific shape and characteristics of the part to be manufactured. The development of the adaptative strategy requires accurate information on the surface topography, position and dimension, both before and after the machining process.

DATAPIXEL is in charge of developing the 3D high resolution measuring system that will be integrated on the USP laser machine. This system will be capable of capturing a high-density 3D point cloud in two steps: pre- and post-process measurement.

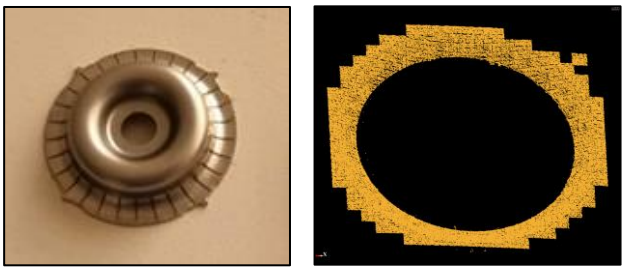


• *Pre-process measurement* of the part before machining will grant information about its geometry, dimensions and topography, and will allow the correct alignment of the physical part with the machine's coordinate system. The measuring system will generate a 3D point cloud, representing the surface topography.

• *Post-process measurement* after machining will grant GD&T (Geometrical Dimensioning and Tolerancing) information that will be used for quality control and as input for possible improvement of the process by machine learning.

Philips use case

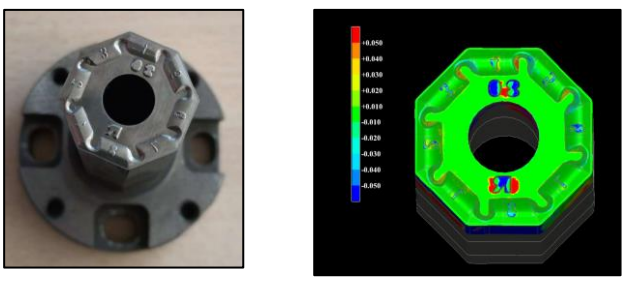
The Philips use case is representative of real parts that are used in high end consumer products, which include very small features that are challenging for many established production technologies. The goal is to develop a sustainable production process that meets Philips product performance standards.



Philips sample (left) and point cloud (right).

Ceratizit use case

In Ceratizit's use case, the part to be manufactured is a very hard carbide punch. The key elements to be measured are the structures machined on the top of the punch, which has an overall shape tolerance of ±10 microns.



Ceratizit sample (left) and deviation map (right).

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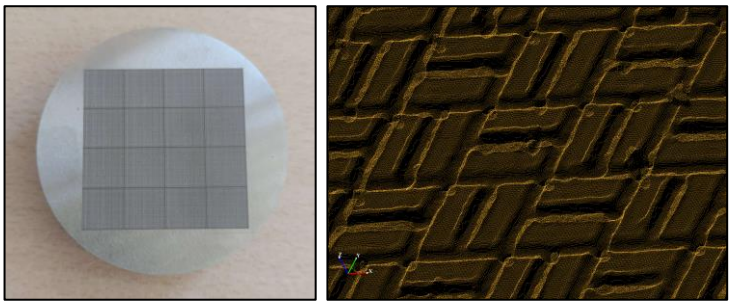
thyssenkrupp use case

In the thyssenkrupp (tkSE) use case, the parts to be manufactured are embossing rolls, which require a specific surface structure to be machined on their surface. In this case, one of the concerns from tkSE was the depth of the engraving textures and the structure shape, as it should be as homogeneous as possible.



tkSE sample (left) and point cloud (right).

The texturing needs to have two depth levels, one at -5 microns from the top surface, and the other exactly level with the top of the sample, with a lateral distance between the structures of 20 microns.

Progress at DATAPIXEL

DATAPIXEL has performed an extensive set of initial experiments to evaluate different optical metrology methods, such as: structured light triangulation, optical microscopy techniques (including depth from focus), interferometry and confocal techniques.

The main challenge is achieving a high axial and lateral resolution while simultaneously having a working distance of several centimetres and a field of view as large as possible.

In METAMORPHA, DATAPIXEL will develop a new type of high resolution sensor that will achieve an excellent compromise between these requirements. This ultra-high resolution sensor will be the base of a new family of DATAPIXEL products, to be integrated for in-machine metrology inspection. Additionally, DATAPIXEL is developing software tools for point cloud processing and analysis, allowing it to automatically extract dimensional information from the high-resolution point clouds.

For more info, please contact Alejandro González: algonzalez@datapixel.com

METAMORPHA 6M meeting at UPV (Valencia, Spain)

Hard to believe that six months has passed already since the start of the project! The consortium met in beautiful Valencia for the plenary meeting in early Mar-2023. It was a very successful meeting, with lots of technical discussion; great to be able to meet face-to-face again after a few years of COVID restrictions.

For more info visit the website or join the METAMORPHA LinkedIn group:
https://www.linkedin.com/company/metamorpha