DIPLAT

NEWSLETTER 1

NOVEMBER 2013

WELCOME TO THE FIRST DIPLAT NEWSLETTER !

Introduction to DIPLAT

DIPLAT is a 42 month research project funded by the European Commission under the Seventh Framework Programme (FP7) to investigate and demonstrate: "Enabling advanced functionalities of **D**iamond and other ultra-hard materials by **I**ntegrated **P**ulsed **L**aser **A**blation **T**echnologies"

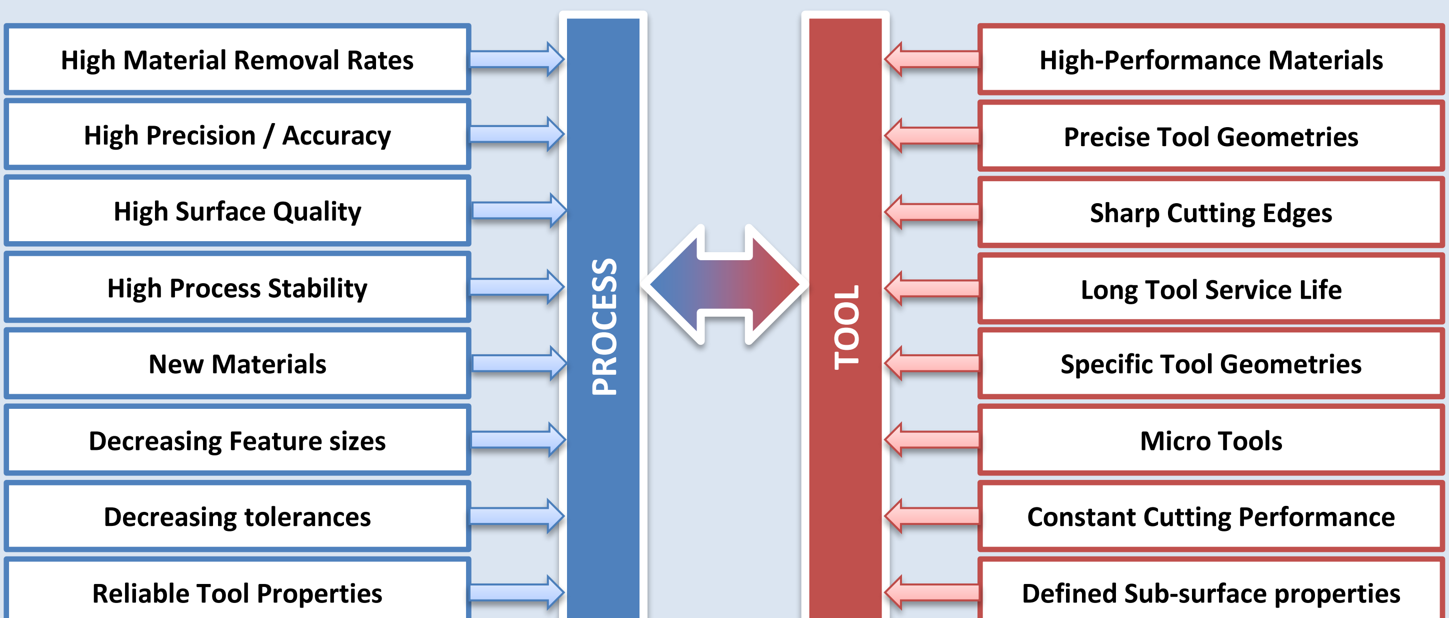
The current machine tool challenge

Modern production systems and manufacturing environments in several key industrial sectors (e.g. automotive, aerospace, medical engineering) have an ever increasing need for high-performance and efficient machining processes. This presents new challenges, not only for the development of machine tools and components, but more importantly for the development and improvement of the tools utilized in these processes. Increasingly, the use of "ultra-hard" superabrasive materials (based upon Diamond and cubic boron nitride - cBN) are being used to meet these challenges; however, these are difficult materials to process conventionally due to their extreme hardness and new, tool fabrication technologies need to be developed to precision shape the tools required by advanced manufacturing.

Typical examples of high-performance machining needs in advanced manufacturing environments are:

- High-Speed-Cutting (HSC) in die and mould production
- High-productive, high-precision grinding of hardened steel (e.g. Gear and ball race grinding)
- Precise Dressing and Truing of conventional grinding tools (e.g. Alumina, Silicon Carbide (SiC))
- Super-Finishing and Ultra-Precision Machining (e.g. Optical surfaces)
- Micro machining (e.g. replication technology for miniaturized parts)
- Precision Machining of super-alloys and titanium (e.g. aerospace industry, medical implants)
- Machining of hard and brittle materials (e.g. glass and optical components, dental implants and other precision ceramic parts)

DIPLAT aims to address these current tool manufacturing challenges (see figure below) using precision, short pulse length laser ablation technologies to demonstrate the technology in an industrial environment.



Requirements to high-performance machining processes and associated tool properties

DIPLAT approaches and objectives

DIPLAT aims to develop and demonstrate an integrated **Pulsed Laser Ablation (PLA)** technology to produce diamond and cBN tools with enhanced functionality for high-performance and ultra-precision machining operations. Enhanced functionality in this regard is defined as:

- ***lower*** machining ***forces***
- ***better*** and more uniform ***surface finish***
- ***robust*** and ***predictable*** tool ***performance***
- ***increased tool life***

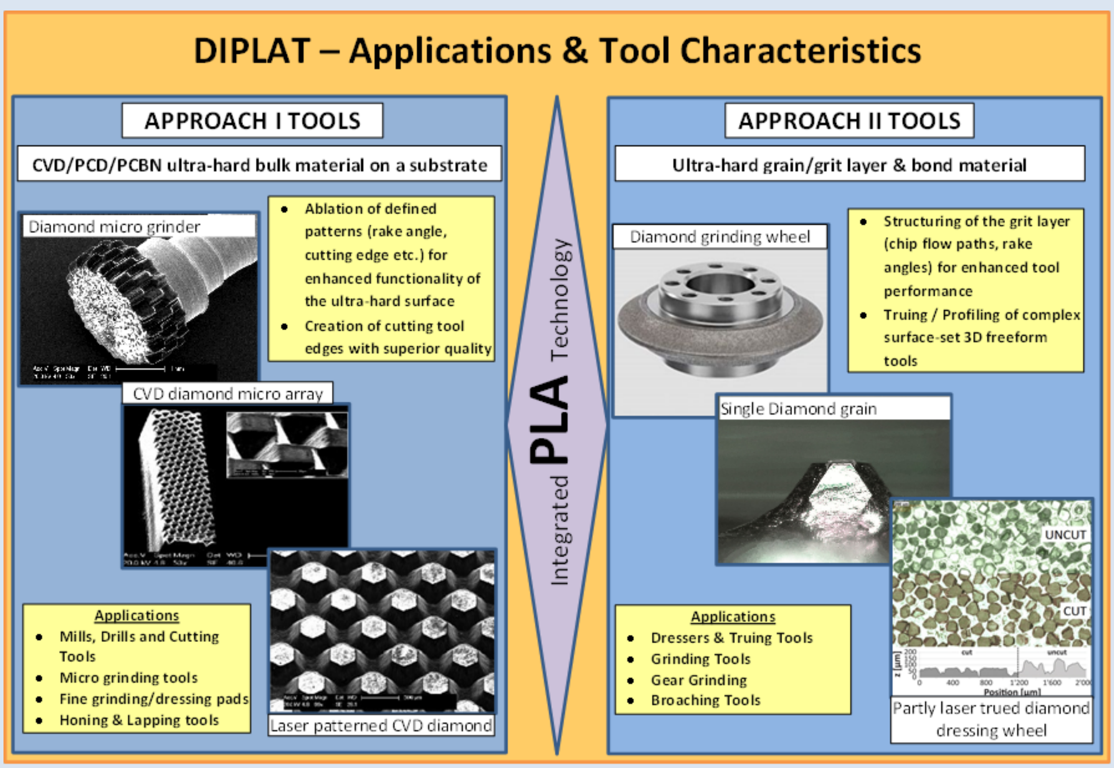
thus, leading overall to ***higher productivity*** of the machining process.

The laser ablation process will be utilized to produce specially designed micro geometries and shapes on ultra-hard/superabrasive tool surfaces in order to achieve a ***regular distribution, function-adapted shape*** and a ***uniform working height*** of the cutting edges as well as a ***high-cutting edge density***. These geometrical properties of the tool will result in the desired improvement of the machining and workpiece characteristics.

Laser micromachining with pulsed laser sources has several key advantages compared to other micromachining processes, which are particularly interesting for manufacturing tools made of ultra-hard materials, namely:

- ***machinability*** of nearly ***any material***
- ***force-free*** material removal, allowing smaller tools
- ***wear-free*** and therefore robust, reproducible and stable process characteristics,
- ***geometric and structural precision*** (laser spot sizes of a few microns), thus higher precision
- ***minimized structural damage*** of ultra-hard material (due to a small/negligible heat-affected zone and thus minimized damage of surrounding material) and,
- ***geometric versatility and flexibility*** of the process (no run-out of the tool).

In addition to the tooling aspects that are the main focus of DIPLAT, the capability to produce complex 3D geometries in ultra-hard materials is of interest for other applications as well (e.g. heat sinks, diamond optics). Hence, the tool demonstrators that will be produced within this project can also be seen as demonstrators to show the manufacturing possibilities of the 3D PLA technology for other applications.



Major applications and concept of DIPLAT tooling approaches

Diamond meso/micro cutting tools

Materiallographic polishing disks

Diamond dressing/grinding tools

How DIPLAT will use PLA to make tools

In order to cover a wide range of tooling processes, DIPLAT will follow two main approaches to produce novel tool surface geometries in diamond and CBN materials, using short and ultra-short laser pulses:

- **Approach I:** ***Structuring/patterning solid diamond (PCD and CVD)/PCBN layers***
- **Approach II:** ***Truing and structuring of diamond/cBN abrasive grain layers***

Polycrystalline diamond (PCD)

Both approaches will in essence, make use of the same PLA technology to produce the desired tool geometries. However, due to the significant differences in the nature of the superabrasive surface (multiple, randomly dispersed individual superabrasive crystals of Diamond or cBN, or a solid, continuous layer as presented by ceramic Poly-Crystalline Diamond - PCD and pure Diamond layers deposited by Chemical Vapour Deposition – CVD), specific machining strategies and process designs have to be developed for each application.

The first DIPLAT approach aims to produce defined cutting edge patterns on solid layers of CVD diamond, Poly-Crystalline Diamond (PCD) and ceramic Poly-Crystalline cBN (PCBN). Plane, solid, ultra-hard layers can be deposited or bonded onto tool bodies of various shapes and profiles depending on the desired manufacturing task (e.g. flat substrates, cylindrical, conical or freeform shafts etc.)..

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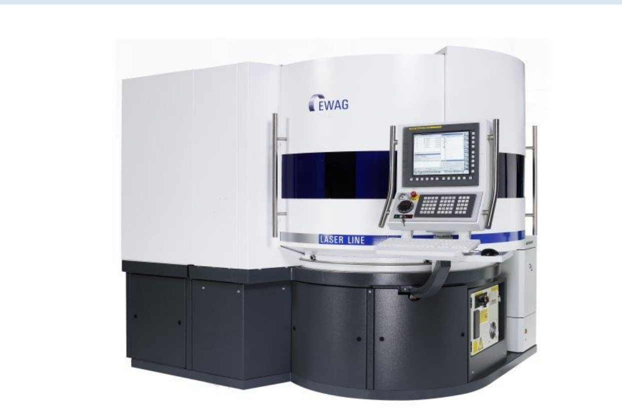
The second DIPLAT approach focuses on novel tool conditioning processes for superabrasive grinding and dressing tools (Diamond / cBN grains + bond).

In order to overcome the shortcomings of conventional mechanical conditioning processes for precision surface-set Diamond and/or cBN tools (monolayer grinding/dressing tools), novel laser-based conditioning process will be developed and demonstrated.

DIPLAT's ambition is to address tooling challenges in high-precision and high-performance applications, however the developed processes are expected to be suitable for other types of tools as well.



EWAG Laser line laser processing machine being further developed under DIPLAT

To demonstrate the industrial viability of the integrated PLA technology for precision ultra-hard tool manufacturing and the quality of the produced tools, extensive testing and characterisation activities ***in an industrial environment using industrial laser processing machines developed under DIPLAT*** are an integral part of the project.

The DIPLAT approach incorporates a wide range of tool applications for Diamond, cBN, PCD and PCBN materials (e.g. milling, cutting, grinding and polishing) and aims to make a fundamental impact on the future development of tooling processes in general. The PLA technology developed within the project will enable the realization of diamond/CBN tools with enhanced functionality and geometrical properties for new applications. DIPLAT will introduce a new technology platform for producing ultra-hard tools with enhanced functionality, outstanding machining performance and superior life-time.

The DIPLAT Consortium

The DIPLAT consortium consists of **8** partners from **5** European countries. The partners are major European academic research institutions with PLA expertise (ETHZ, University of Nottingham), an industrial ultra-hard materials supplier and developer (Element Six), SME innovative processing technology leaders (EWAG/WALTER, Zeeko) and advanced tooling and equipment specialists (Diamoutils, Struers, Reishauer).

Therefore, the DIPLAT consortium forms a critical and complementary mass of expertise in advanced tooling technologies, ultra-hard diamond/CBN materials and their applications.

DIPLAT website: http://www.fp7-diplat.eu

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