CarbideInsertDie SC_V.2EN_ 05/ 2023

DLyte **The metal surface finishing revolution**

SUCCESS CASE. CARBIDE INSERT DIE POLISHING

For the Cutting Tools Industry

Powered by DryLyte® TECHNOLOGY

A brand of GPAINNOVA

CARBIDE INSERT POLISHING.
For the Cutting Tools industry

THE COMPANY

GPAINNOVA's client is a company specializing in designing and manufacturing high-quality carbide inserts.

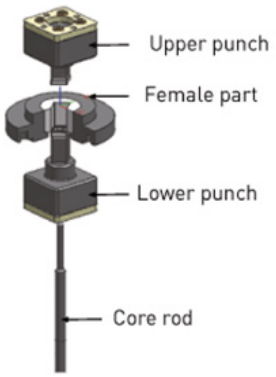
"Surface quality of carbide insert dies affects productivity, quality, and aesthetics of the insert."

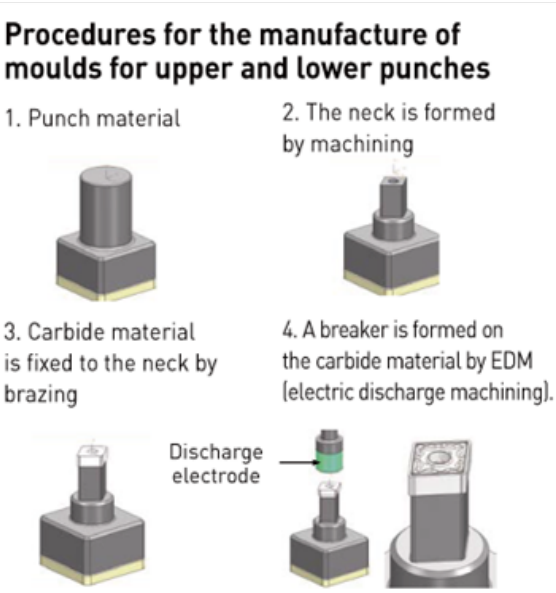
THE PROBLEM

Carbide inserts are replaceable bits of cemented carbide used in machining. The use of inserts allows faster machining and better finishes in metal parts, as they can withstand higher temperatures than high speed steel tools. Additionally, using the carbide only at the cutting interface reduce the high cost and brittleness of making the entire tool out of carbide.

Cemented carbides are composite materials in which irregular shaped tungsten carbide particles act as the aggregate. At its turn, a metallic binder serves as the matrix. The process of combining both materials is known as sintering.

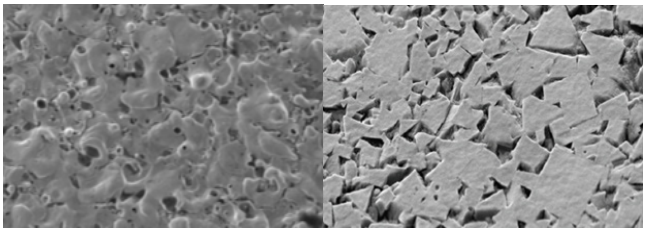
Manufacturing carbide inserts is a complex process with several steps. One of them is the powder mixture pressing, carried out in a press with 12 tons of pressure. The mixture is pressed by carbide punches, which require to be precisely manufactured to produce high-quality inserts.





Polishing carbide insert dies is a resource-intensive activity, as it is based on manual polishing. Besides taking hours, it leads to non-satisfactory results. There are no alternative processes to polish carbide dies automatically. The average time required by a skilled polisher to polish insert dies is 8 hours per piece, with an approximate cost of €300.

Existing mechanical surface finishing processes are not effective in polishing tungsten carbide, as it is too hard to be eroded and therefore the improvement of surface quality involves an uncontrolled rounding of the edges. Alternatively, chemical and electrochemical processes corrode and the cobalt is spontaneously released in a reaction that is commonly referred to as leaching. Leaching supposes the loss of the binder metal and the structure collapses whilst it is in service. In the picture below the black areas are empty spaces where the cobalt binder has been removed by the corrosion of the surface finishing process.



Initial Surface *Surface after polshing with leaching effect*

The company identified that surface finishing of carbide insert dies could be automated to improve repeatability, quality and to lower production costs.
Before adopting GPAINNOVA's solution, the customer was applying a manual polishing piece by piece with an average time per piece of 8 hours.

THE GOAL

The company was looking for how to improve production capacity and quality and reduce cost of polishing of carbide insert dies. The customer needed to surface finish the tools to get higher quality and longer lifecycle of the punch.

Concerning the target, it consisted in mirror surface finishing and a significant roughness reduction and brightness to achieve a Ra goal below 0.01 microns (0.4 microinches) without affecting the edges.

THE SOLUTION

The customer prepared a batch of samples of tungsten carbide insert dies.

The parts were produced by pressing and sintering cobalt and tungsten carbide particles and EDM (Electrical Discharge Machining) to the exact size, geometry, tolerances, and a resulting roughness measured of 0.24 microns Ra (9 microinches). The targeted Ra after the process was under 0.01 microns (0.4 microinches). Surface finish is often called out on part prints. Sometimes, it is because it has an impact on the appearance, since it affects how surfaces slide over one another. Bearing surfaces and those used for sealing are examples of where finish is important. An EDM surface finish is different to that produced by conventional machining.

GPAINNOVA's Process department defined the electrolyte based on the material and the initial and targeted roughness. After this, the Engineering department developed a fixture to hold the pieces during the process, especially prepared to avoid shadows, preventing part damage by impact, and maximizing the capacity per cycle of the selected solution. The equipment recommended by the Process department was a **DLyte 100PRO Carbide**, a compact machine with high output, specially designed for low production. The movement and speed applied was defined to ensure a perfect media and electrical flow through the whole piece.

The main factors that determine the cost per piece are defined by CAPEX (which depends on the equipment required, linked to the yearly production, the batch capacity, and the process time per batch) and OPEX (which is defined by the weight removal per piece, media lifespan for the material and maintenance costs).

The media lifespan is determined by its metal absorption capacity, as the metal removed from the pieces is captured by the media particles. The way we use to calculate media's lifespan is linked to the quantity of metal that the consumable can absorb before losing effectiveness. This way, GPAINNOVA was able to calculate the number of pieces that we could treat with the media, based on average metal removal weighted on a sample badge. Metal absorption capacity of the media is different between materials, as the material's density changes substantially in different metals. For heavy metals and alloys, metal extraction is higher than for light metals alloys.

Different tests were performed in order to define the ideal process **to reach the technical specifications of the surface and lowest total process time and cost.** Technical specifications include high-gloss polishing of the insert die to decrease surface roughness below 0.01 microns (0.4 microinches). As it should be kept the radius unaltered, the part is immersed in the electrolyte with a cover to protect the edges. One advantage of the technology is that if the art of the piece should keep unaltered. A mechanical masking can be applied easily and removed after the process is applied.

GPAINNOVA made trial runs applying different process times and parameters, and conducting roughness measurements with a profilometer and a microscope in different areas before and after the process.

The best results were achieved with dry suspension media, a solution based on gel particles and an electrically non-conductive liquid. The non-conductive liquid protects the surface of the piece against the oxidation created by oxygen present in the air. The processing time was 90 minutes for one piece, starting with an average roughness of 0.25 microns (9 microinches) after manufacturing process and a final roughness below 0.01 microns (0.4 microinches). The mass removal was a gram per piece.

Considering a weight removal of one gram per piece and the weight removal capacity of a full media work bowl of 16 liters –in the case of carbide with dry suspension media, it is 0.3 kg–, GPAINNOVA, thanks to its DLyte solutions, can treat 3,000 parts per media lifecycle. Based on the processing time of 90 minutes and an estimated total time for loading and unloading the holders of 2 minutes, total process time is 92 minutes per batch of one piece. The daily output considering one shift is 5 insert dies, and the annual output (assuming 250 working days) is 1,250 units.

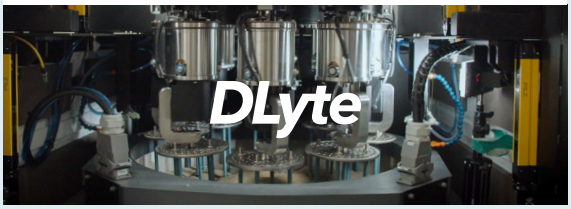
According to GPAINNOVA's experience, the achievable roughness values, material removal and process' time may change depending on the geometry and the initial state of the surface before being processed with the DryLyte Technology.

CURRENT STATE OF FINISHING

Manual Polishing: 8 hours

DLYTE FINISHING SYSTEM

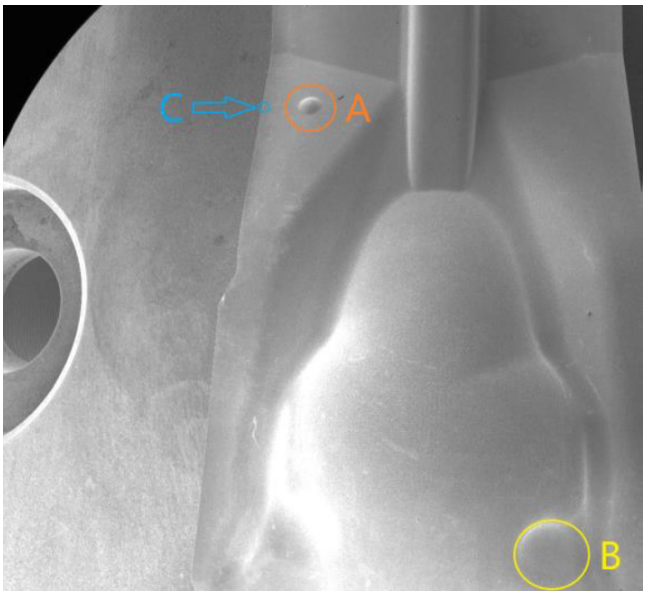
***DLyte 100PRO Carbide* (92 minutes)**



Those are the costs per piece based on the material removal, process time, and capacity:

OPEX cost per part: €1 (including media, maintenance cost, electricity and air consumption)

CAPEX: : €36 per piece for 5 years with 1,250 pieces/year (including equipment and customized holder investment)



General view of the punch (three different investigated regions are overlapped in the SEM image).

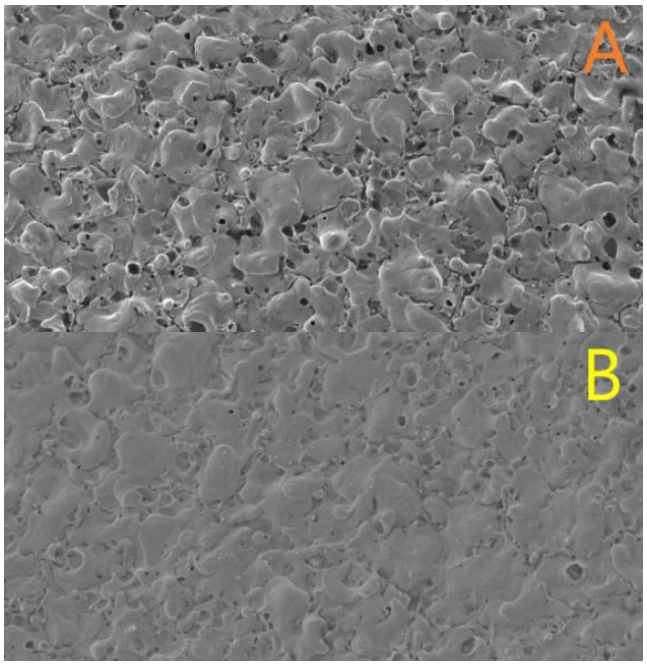
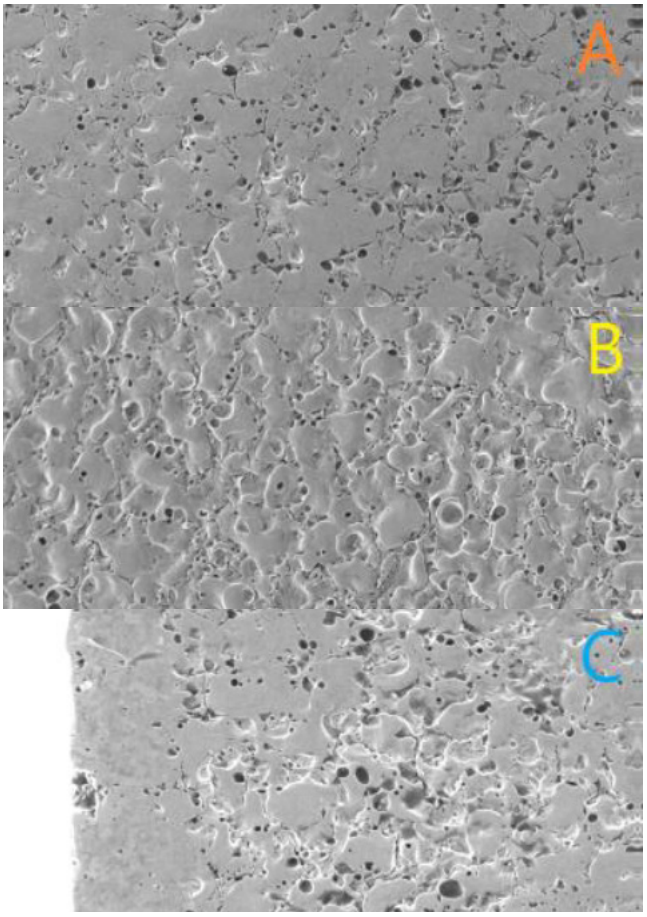
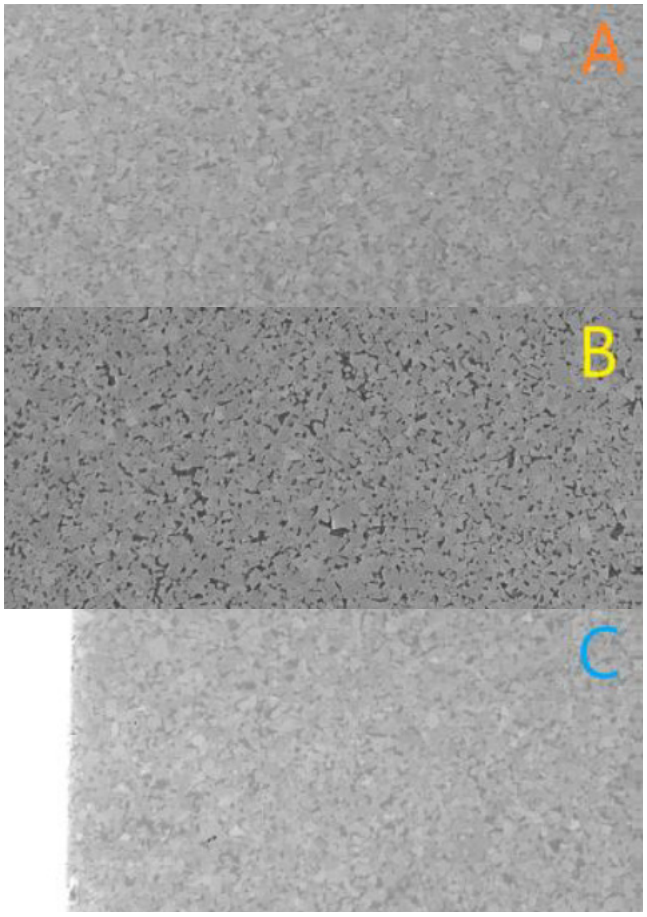


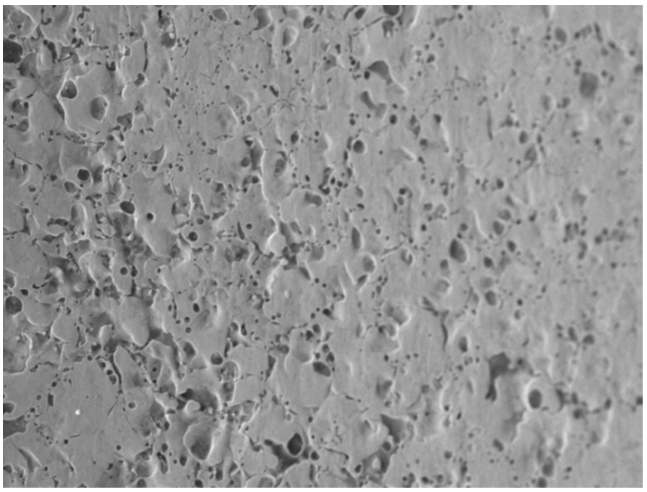
Image shows the SEM micrographs of the as-received surface of regions A and B of the EDM.



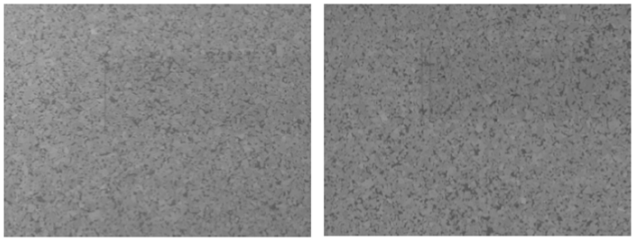
SEM micrographs after 15 min of dry-electropolishing process for the three regions investigated here.



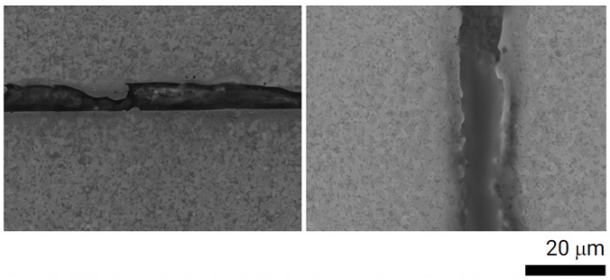
SEM micrograph showing the final stage after 60 minutes of dry-electropolishing process for each of the different investigated regions.



SEM micrograph showing the EDM layer after 10 min of dry-electropolishing process.



SEM micrographs showing the microstructural after 60 minutes of dry-electropolishing process.



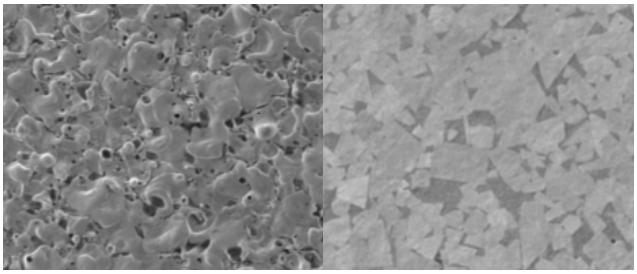
SEM micrographs showing the interface between the punch and the perimetral protective employed along the entire polishing process after 60 min of dry-electropolishing process.

BENEFITS

Among **the new DLyte surface finishing process' main technical benefits,** it is worth to highlight the following ones:

01. NO LEACHING EFFECT

The Dry Suspension electrolyte removes ceramic and metallic phases as equal, thus avoiding cobalt leaching on inserts. This way, the technology does not make the part more fragile, as it happens with other surface finishing methods. See the article about it.



02. HOMOGENEOUS RESULTS ACROSS THE PIECE AND THE GEOMETRY & TOLERANCE PRESERVATION

DLyte is more precise and homogeneous than current grinding process, as material removal is performed by an electrochemical process which depends on the number of impacts of the media against the surface, and the electrical field. The DryLyte Technology makes the polishing of inserts precise and reliable, without losing tolerances and radius.

03. BEST-IN-CLASS CONCERNING SURFACE ROUGHNESS (RA UNDER 0.01 MICROMETERS)

DLyte can reduce the roughness over 80 percent without side effects. There is no other automated process able to process the parts defect free with the required surface quality and without modifying the cutting-edge radius.

04. STABLE RESULTS AMONG DIFFERENT BATCHES WITHIN THE ELECTROLYTE MEDIA LIFESPAN

Dry electrolyte does not require maintenance, as the media absorbs the metal ions during the process and the cathode remains clean, thus achieving high-quality finishing results with zero scrap rates. The previous manual process was inconsistent.

05. LONGER LIFESPAN FOR TREATED PARTS

Defect free and isotropic surfaces

+ The DLyte process produces an isotropic non-directional finish improving the surface finish and providing repeatable, non-directional and uniform finish, as there is no surface abrasion. Instead, material removal of material is produced by ion transport. The previous manual polishing process used abrasives as diamonds, with a high risk of inclusions and directional lines.

Among **the new DLyte surface finishing process main operational, economic and environmental benefits**, it is worth to highlight the following ones:

06. REDUCED FOOTPRINT

DLyte process features high output in a very compact footprint. Manual polishing would require several manual polishing stations to process the same number of pieces processed by just one DLyte 100PRO Carbide.

07. COST AND TIME REDUCTION

The new process supposes a production cost reduction over 95 percent, including process, logistics, improved quality, and reduction of rejection and scrap of punches. The automated process is able to process one unit in 90 minutes.

08. EASY WASTE MANAGEMENT

The dry suspension electrolyte waste management can be easily handled by standard services. At its turn, all the metal removed from the workpieces remains in the media. As it is solid there is no risk of discharge in waterways or drains.

09. EXPOSURE OF WORKERS DURING PROCESS AND MAINTENANCE

DLyte process does not generate dust or heavy noise. Metals removed from the workpieces remain in the media, so workers are not exposed to the noise or dust. Manual polishing involves exposure to dust, noise and toxic particles to workers.

10. HANDLING AND STORAGE OF MEDIA

DLyte solution for carbide uses solid electrolyte media with a non-conductive liquid without acids, which can be handled and stored without additional safety measures. It is not harmful for workers and, since it is solid waste with a, its handling reduces the probability of discharge in drains and waterways.

> How to know when the electrolyte needs to be replaced?

DLyte Technology incorporates a software that calculates the electrical charge accumulated during the polishing cycles, a parameter that is directly proportional to the mass extracted during the cycle. The system enables the operator to adapt the parameters during the lifespan of the media to compensate the age of the electrolyte and to guarantee repeatability and performance. Once the media arrives at the end of its lifespan, the machine indicates that the consumable needs to be replaced by a new one.

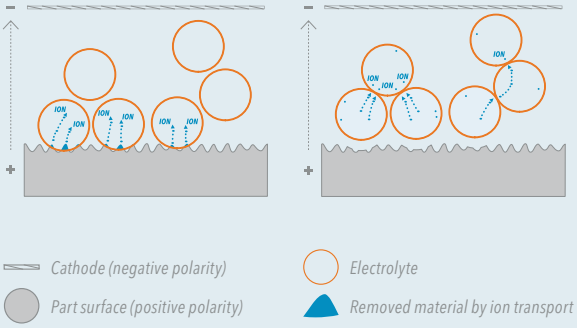
> How does the DryLyte Technology work?

The technology combines the mechanical surface finishing and liquid electropolishing processes, being able to reduce the surface roughness without impacting on the original geometry as the removal is based on ion transport instead of abrasion of the surface.

The equipment uses electricity with specific electrical parameters and moves the parts fixed by fixtures inside a tank full of media. Every time an electrolyte particle impacts the metal surface, there is an ion transport that removes irregularities from the peaks of the surface.

DRYLYTE TECHNOLOGY PROCESS

DryLyte is a patented technology for grinding and polishing metals by ion transport using free solid bodies. DryLyte Technology works by combining the electrical flow created by the high-precision rectifier with the movement of the pieces through the electropolishing media. This results in an ion exchange, **removing material only from the peaks of roughness. The process does not round edges** and can access internal corners that are not easily accessed mechanically.



> Why trust GPAINNOVA and DLyte?

A personalized assistance for GPAINNOVA's clients is assured during all the DLyte journey, thanks to our experienced teams that:

+ Advise customers to find the most suitable polishing process
+ Design and customize the best solution for the customer
+ Ensure a proper production performance (achieving target cost, lead time and surface quality results)
+ Train customers to take the most of the DLyte Technology
+ Solve any doubt about the technology and the equipment
+ Promptly assess any maintenance service needed

Thanks to this, we count on:

+ More than 900 satisfied customers worldwide
+ More than 950 machines installed
+ 60 distributors in 5 continents
+ More than 10 years of expertise in surface finishing processes

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