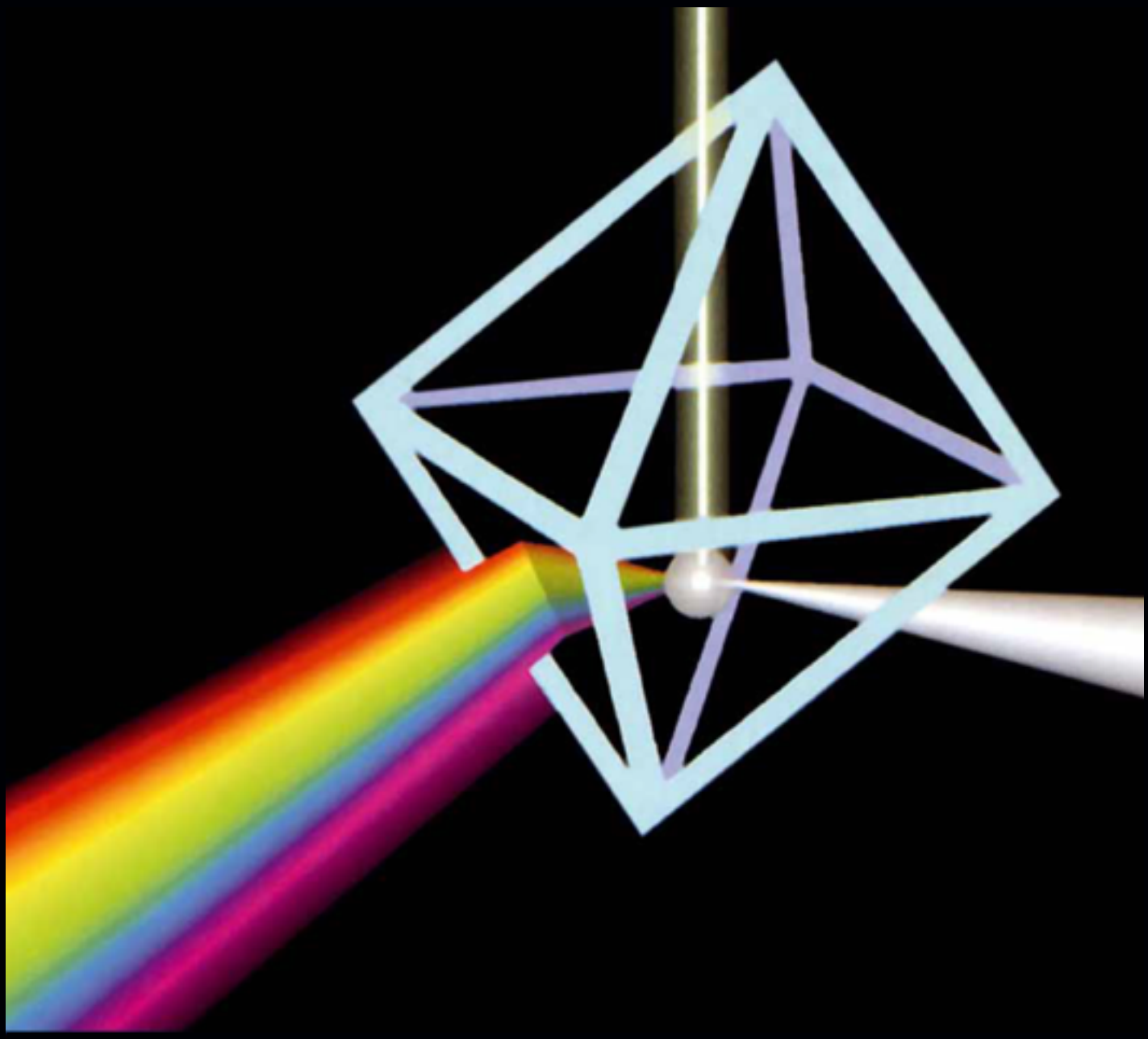


"Poly - poly - or what"

Part 10: When sparks learned to fly on diamonds …

“Poly – Poly - or what?”

Part 10: When sparks learned to fly on diamonds …

Horst Lach, managing director and CEO of LACH DIAMANT, agreed to write an ongoing series of articles about the development of diamond and CBN tools and grinding wheels in modern industries.

Horst Lach is known as a true industry veteran, and we are excited to have this pioneer of technology share some insights from his 59 years of professional experience in the diamond tool business. In this episode, he will let the sparks fly.

While I am writing this, EMO Hanover is already history. Once again ADAMAS – the invincible diamond – showed all its facets. It is still the hardest of all materials. But I think, we do not have to fly to the moon or further experiment in space labs – thanks to human ingenuity, we have many opportunities on our planet to discover new facets of this material. One could argue that, after 1957, after the first introduction of man-made-diamonds, there would have been enough time to develop an even harder material – but we must consider the revolutionary developments within the industry in the last century.

I remember a few innovations and pioneering activities which became essential in everyday life, for our daily work and recreational activities. Without claiming completeness, I will mention Thomas Edison who invented the electric bulb 1879 – 1890 and developed it further until it could replace incandescent gaslights. The discovery of the crystal detector, driven mainly by J. C. Bose and F. Braun between 1904 and 1907, led already in 1906 to a radio receiver which operated on electronic principles and which allowed for the first verifiable radio broadcasting. The beginning of our modern colourful media world.

Ford’s first mass-produced “Model T” marked for many the real beginning of the industrial revolution of the last century. And even though the media hailed Lindbergh´s first non-stop flight from Europe to America as sensational, he had already been outraced by the first successful non-stop flight of John Alcock and Arthur Whitten Brown in 1919; this should not detract from Lindbergh´s pioneering success of the first solo flight.

A Pioneering Act Regarding PCD

Let’s transfer this perspective to the “diamond” – naturally grown, it was hidden within the earth for millions of years. In early ancient times in India, it was already used for dressing millstones – not to mention its special allure as a gemstone.

Dressing and fine dressing of conventional grinding wheels made the diamond a material of military importance in both world wars. Without diamond tools for the dressing of grinding wheels, for example in the ball and roller bearing industry, precision results would have been inconceivable. The final development of the first man-made diamonds by General Electric during the 1950s – during the Korean War – also reflected concerns of the USA to be cut off from diamond imports. It took well over 15 years from this development of the first synthetic diamonds with up to 150 Mikron until General Electric surprised in 1973 with the worldwide first available polycrystalline synthetic diamonds (PCD). [1,2] Meanwhile, the ongoing development of synthetic diamond grains had further proceeded and had revolutionized the grinding of carbides and ceramics.

All Beginnings are Difficult

In the beginning, it was very difficult, if not impossible, to machine polycrystalline diamonds. Even experienced diamond cutters failed to give it a suitable geometry comparable to natural diamond blades. “We cannot grind this beastly material – it does not show any growth.”

1982: M-900

1986/87: M-1050

1987/88: M-1050-C

1989: Z-2000

1991: M-2050-memo-automatic

1996: M-4040-CNC

Precision grinding machine, model »pcd-100« with rocker for grinding PCD/PCBN inserts and diamond grinding wheel.

Now, we know what happened next: When all attempts of trained natural diamond cutters failed, it was up to a resin bond diamond grinding wheel, mounted on a simple carbide and steel grinding machine, to conquer this new material, even though it was time-intensive to do so.

The first functional PCD turning tool for machining non-ferrous metals and plastic materials had successfully been created. During the following years, an independent production shop with highly motivated employees emerged at LACH DIAMANT and focused entirely on the development and application of PCD tools.

The initial Simon test machine for steel grinding had been co-developed into a tool grinding machine together with the Kelch company, and it is still manufactured and distributed today as "pcd-100" and "pcd-300", respectively. Now, the production of PCD turning steel and indexable PCD insert tools was easy and highest precision was possible.

In the following five years, tools with multiple edges, such as PCD end mills, milling cutters, scorers and saws, were produced on an experimental basis. [3] However, the production of these rotating tools was very time-consuming and cost intensive. The production of tools with profile-ground cutting edges was almost inconceivable. At this point in time, at the end of the 1970s, this new "PCD" cutting material had not yet captivated the industry – particularly the automobile industry. How should it be otherwise; aluminium-based engines were just in their beginning or planning stages.

As Chance Would Have It

An accidental discovery in October 1978 [3,4], for which I spontaneously filed a patent application, should from now on change the further development of polycrystalline synthetic cutting materials worldwide.

The "electric spark" was discovered as medium for a target-oriented forming of the previously "beastly" polycrystalline material, known as PCD, for the tool manufacturer and in particular for its imminent "success story" in the automobile, aviation and furniture, wood and plastic processing industries.

The patent application in question, with priority of October 13th, 1978, was published as European patent on April 21st, 1982, for a "procedure for machining a polycrystalline synthetic diamond and use of this so-machined diamond."

To place this event in a historical context: Up to this discovery, even manufacturers of polycrystalline diamonds (PCD) such as General Electric – and later, at the end of the 1970s de Beers – were unable to efficiently divide their produced PCD circular blanks into segments.

For want of other techniques, the composite PCD material, consisting of a "baked on" diamond layer with an initial thickness from 0.3 to 0.8 mm, would be scored at the desired segment using a thin diamond cut-off wheel and afterwards broken (including the diamond) – at the time this was state-of-the-art technology.

During my intensive research regarding this and following reports in connection with the "spark patent", I found in the professional correspondence of a GE lawyer from November 1983 that GE only then had become aware of using electric sparks as a means for dividing and forming PCD.

The following developments at LACH DIAMANT are presented in my previous "Poly – poly – or what?" reports [3, 4, 5]; as well as the, quasi per chance, additionally arising business segment of "diamond tools for wood and plastics" which led to the foundation of LACH-SPEZIAL-Werkzeuge GmbH. "Now Lach lost it completely – he wants to machine wood with diamonds" were typical comments at the time.

The further development of NC and CNC machine technology made diamond tools worldwide indispensable for the wood and composite processing industry, the beginning of a triumphal success; but I will cover this in one of the next editions.

A look inside: Part of the production area for diamond tools for wood and plastic materials, in use since 1984. Clearly visible in the front, the vertical eroding machines - In the back, machines of the first generation of the M-900 series for spark grinding of Straight-edged diamond tools.

Like Winning the Lottery

The possibilities resulting from the discovery of spark erosion for the efficient machining of polycrystalline synthetic cutting materials, PCD and also CBN-PCBN, were like a lottery win for the "bundled" LACH DIAMANT and LACH-SPEZIAL businesses. In addition, license and know-how sales contributed their part. The move to the present head office in Donaustrasse in Hanau was conducted in 1984.

Despite all euphoria, the question remained how I could control the sparks in order to best use their "erosion potential" for machining, forming, profiling, and cutting polycrystalline cutting materials. All this while the competing cutting material carbide had just become "fashionable." 8

What "spark generating device" was available to us on the market in 1978/79? On the one hand, there was the so-called vertical erosion machine and on the other the erosion wire machine (EDM) which was still in a development stage (NC with punched tape).

Subsequently, we got to know both procedures, one at the former Matra company (EDM) and the other at Nassovia (vertical erosion). That is why the PCD cutting edges of the worldwide first diamond profile milling cutter for wood and plastic machining were formed on an EDM machine at Matra.

This diamond tool with semi-circle overlapping cutting edges, with 13.4 mm diameter each, was delivered to the Resopal H. Römmler GmbH factory in Gross-Umstadt. Now at the very latest, we had to make a decision since the customer announced further orders after the initial successful implementation: Wiring or Sinking?

The time of "free trial work" was over; we had to make an investment. Initially, we decided to use both technologies.

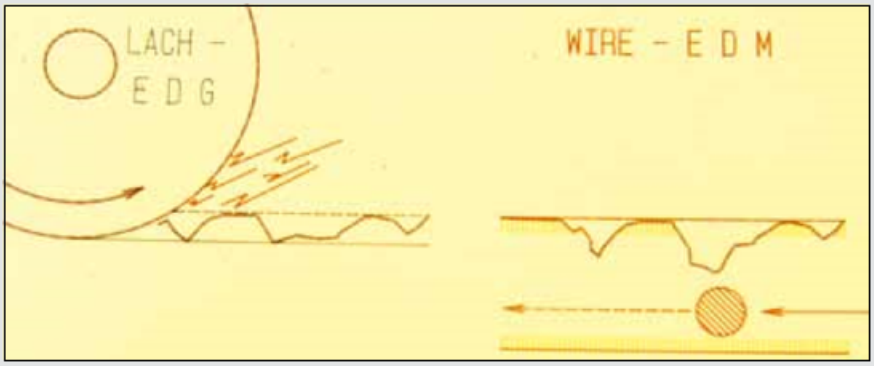
- **Wire:** The cutting quality was insofar usable (as of 1979) – however, too time intensive for running it over all the cutting edges of a milling cutter.

- **Sinking:** The entire electrode width could be utilized for each PCD cutting edge, even as profiled electrode. An advantage – and in the end a significant time factor compared with wire technology.

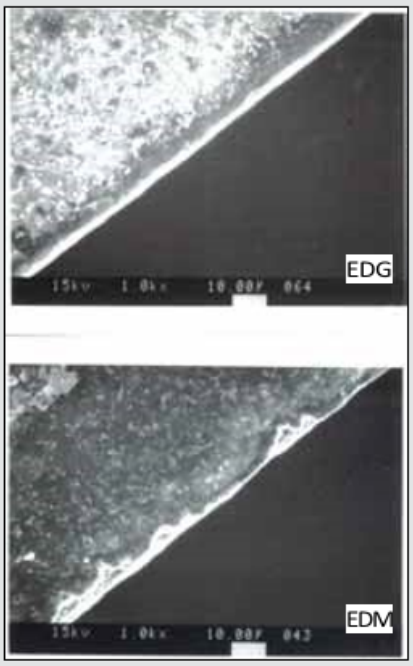
In both cases, we can already observe "travelling sparks", while the sinking procedure is superior to the wiring because the wider electrode is more efficient than the thinner wire when it comes to diamond removal and forming.

Always Room for Improvement

Initially, it was necessary that one worker per vertical eroding machine had to manually advance each tooth of the diamond milling tool to the electrode. This was the beginning of LACH DIAMANT's machine engineering which automated this process "tooth by tooth." At first, this helped to avoid an explosive increase in manufacturing costs. But after brainstorming further – there was still room for improvement! This new technology, utilizing sparks to produce polycrystalline diamond tools, was a never before realized symbiosis. "Why not simply bend the rigid electrode – make it circular?" Voilà! What was the result? The circular electrode –



Addition to left column: Comparison of edge zone damage for original LACH EDG Procedure and EDM wire cutting. Gegenüber dem EDM-Verfahren verhindert der kontrollierte Funkenspalt bei EDG eine Randzonenschädigung – unnötige Zustell-tiefen bzw. tiefes Eingreifen in die Matrix sind dabei nicht erforderlich – ein weiteres Nacharbeiten kann entfallen.



Comparison (as of 1988) of original LACH EDG procedure (image on top) and EDM wire cutting (image at bottom) using the example of a cutting edge (magnified 1,000 times). Clearly visible for EDM is the damage in the edge zone which can be up to 0.02 mm and therefore impacts tool time significantly.

1999: *Dia-2100-CNC*

2000: *Dia-2100-classic*

2000: *Dia-5085-CNC*

"EDG-Plus spark grinding" demo on a »Dia-2200-mini« at GrindTec 2018.

"rotation eroding!" And therefore, the birth of the electrical discharge grinding procedure – that is "EDG."

Whether copper or graphite carbon, both are perfect for EDG; however, the graphite electrode comes with the advantage of easier profiling. We chose the name "spark grinding", a "touchless grinding", and we added the English term "gentle touch."

"Touchless grinding" triggered an order for ten smaller engraving machines from our "novice" machine engineers in Taiwan, with the plan to equip those later with spark generators – in fact "touchless", but nevertheless, the less precise, instable axes of these machines ultimately had to be moved. You can surely imagine the result. "This method did not acchieve the desired eroding result."

Thanks to newly employed experienced machine engineers, such as Armin Staub who is still active today, LACH DIAMANT spark grinding machines evolved into long-lasting machines with the required stability.

Regarding the spark generator and the special software controlling sparks and axes, LACH DIAMANT was able to employ the services of a young, dynamic business under the management of Andreas Weber.

Years ahead of its Time

This cooperation is one reason why LACH DIAMANT EDG spark erosion grinding machines were already years ahead of any potential future competitors.

Except for license and know-how sales, LACH DIAMANT machines which by now had completed several internal development stages, were not sold to any third parties. (See photo series)

This changed in the run-up to LIGNA 1987 – long since, LACH-SPEZIAL diamond tools for serial production had become irreplaceable tools at big companies within the furniture, kitchen furniture and door manufacturing industry. Always ahead with the slogan: 250 – 300 times superior to carbide!

On markets such as West Germany, the Netherlands, Belgium and Italy, the now so-called DIA tools were being used, and with a high increase in sales rates. In addition, Swedish companies tested diamond tools in the production of laminate flooring.

In the USA, the introduction work of the newly founded LACH DIAMOND INC. subsidiary in Grand Rapids had noticeable effects. Inevitably, this led to longer and longer service times for resharpening the long-lasting diamond tools which could be resharpened between ten to twelve times.

For a Selected Audience Only

During and after LIGNA 1987, after a press release from LACH-SPEZIAL Werkzeuge GmbH, the trade press took up the topic of service and tool grinding and published that "… these services are now available to interested diamond tool users via a diamond tool grinding machine… ", naturally also the direct customers for diamond tools – however, you can imagine the crowds of traditional wood tool manufacturers and grinding shops at the LACH DIAMANT stand at this LIGNA. Especially, when they had to find out that viewing this (so far unknown) masterpiece of a diamond grinding machine was kept for an exclusive audience only. The machine, presented for the first time ever, was at the time already perfect state-of-the-art technology. Back then, it was a M-1050 automatic with five axes for production and resharpening of straight-edged and angled diamond tools – from end mills to diamond mills, hoggers, scorers, saw blades with up to 400 mm (today's »Dia-2200-mini« up to Ø 540 mm) and all tooth shapes.

Some "hot tempered" individuals tried everything possible, even illegal measures, to see a presentation refused to them. One case still makes me smile: An entrepreneur and tinkerer from Westphalia had an idea. After exhibition hours, he organized a ladder in order to see the spark grinding machine »M-1050-Automatic«, so far withheld from his view, from the back of another stand.

With the sale of LACH DIAMANT technology – "spark grinding machine" utilizing EDG procedures – the diamond tool experienced a boom on the Italian market and in other countries. However, not the large diamond consumers ordered the machines, but rather many small tool grinding shops with three to five employees.

This is the reason why – when I visit LIGNA today and see all the magnificent stands of diamond tool manufacturers – I can rightfully say: "All of these are my children… ."

Horst Lach

2005: *Dia-2100-mini*

2014: *3DiaSawGrinder*

2016/2019: *Dia-2200-mini*

References:

[1] *"Poly – poly – or what?", part 1: http://bit.ly/Poly-poly-1*
[2] *"Poly – poly – or what?", part 2: http://bit.ly/Poly-poly-2*
[3] *"Poly – poly – or what?", part 4: http://bit.ly/Poly-poly-4*
[4] *"Poly – poly – or what?", part 5: http://bit.ly/Poly-poly-5*
[5] *"Poly – poly – or what?", part 6: http://bit.ly/Poly-poly-6*