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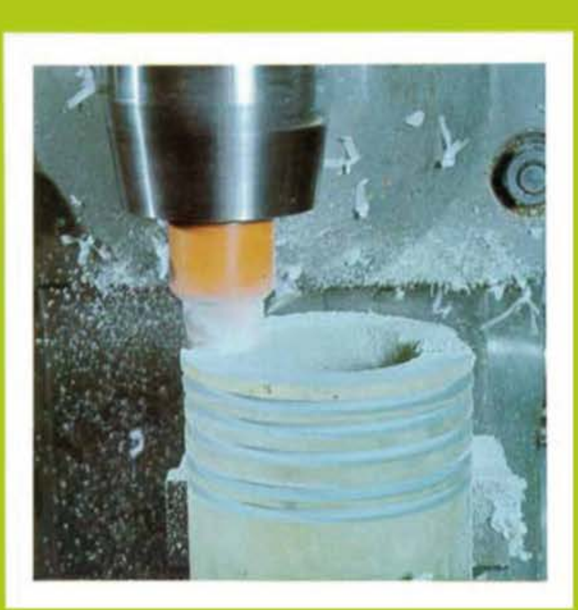
Machine Tools, PCD, PVD, CVD, CBN, Hard Metal

LACH-DIAMANTEN
Trennen · Fräsen · Entgraten
Fasen · Bohren
GFK, Duroplaste, Quarzglas und andere Werkstoffe



Entwicklungsstand 1974
This title is the original cover picture of a catalogue - stage of development: 1974

"Poly - poly - or what?"

4th part

How a trade show initiated a brilliant idea...

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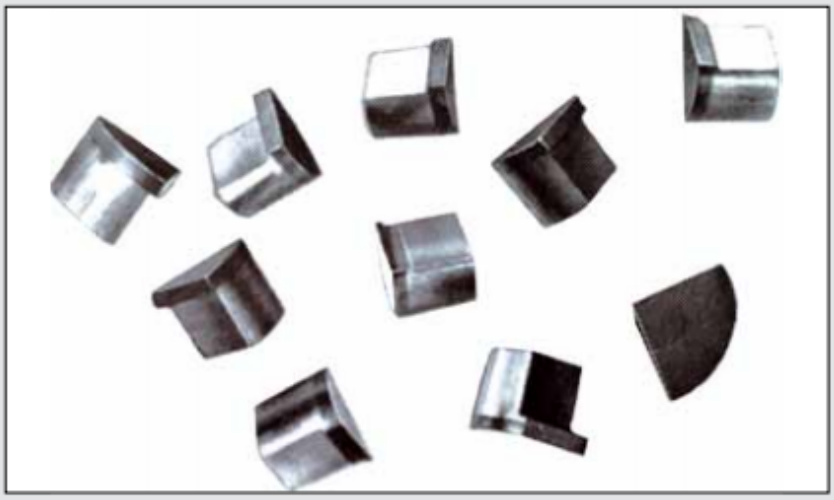
4th Part

How a Trade Show initiated a brilliant idea…

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 over 57 years of professional experience in the diamond tool business.

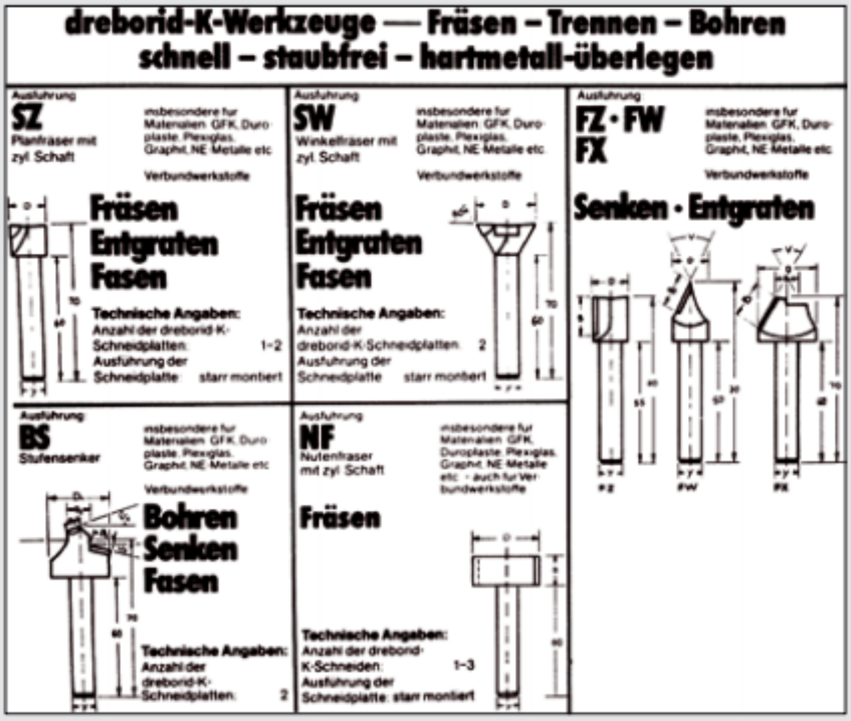
In the sixth part of this (almost) historical review, Horst Lach recalls a brilliant idea.



Unmachined synthetic cutting inserts – developmental status as of 1973. The shown segments with 60° and 90° angles were mechanically cut out of PCD blanks (of approx. ø 3.4 mm) with diamond cutting wheels.

Between 1974 - 1976 polycrystalline cutting materials – diamond (PCD) as well as CBN (PCBN) – could show their potential for the first time[1]. As a result of the hardness of diamond combined with the sharpness for machining tasks, the superiority of PCD was displayed early on: Turning – Milling – Drilling – Cutting.

Nevertheless, this particular cutting material was at that point still a niche product. The world of global players within the automotive industry had not yet discovered it – or had not yet realized its cost-cutting potential. There were several reasons for this.



Excerpt from catalogue "*Trennen, Fräsen, Entgraten, Bohren von GFK, Duroplasten und anderen Werkstoffen mit PKD-Werkzeugen*", published on the occasion of *productronica 1977 – in the beginning, the schematically shown shank tools could only be fitted with segments from approx. ø 3.4 mm circular blanks.*

When the polycrystalline diamond was first introduced to the industry in 1973, tool manufacturers had only been able to grind carbide, a similar cutting material, efficiently, i.e. in a cost-effective way, for about five years. And again, diamonds – to be more exact – the grinding wheel that was available for carbide cutters at the time played a role in this.

Until around 1967, diamond wheels were only referred to as polishing wheels, and therefore not suitable for pre-grinding processes. The reason for this was that the synthetic and natural diamond grains in resin-bond grinding wheels would fall out of the bond after approximately 1/3 of their product life.

Only after the diamond grains were coated with nickel cobalt – an innovation of the company Asea – was it possible to create a lasting, coralline surface connection between the resin bond and the individual diamond grains. Pre-grinding of carbides was now possible and initiated a boom-like upswing of the carbide industry. It could be questioned whether polycrystalline cutting materials came too early (for the industry).

PCD - Too early for Many

In this regard, in the beginning of the 1970s, turning machines with microprocessors for CNC production did not exist yet. First attempts were made about 1978. Until then, turning was mostly done manually – outside of a few exceptions with perforation stripe controls.

For the carbide industry, and especially for the booming manufacturers of carbide tools, the synthetic and at the time still controversial diamond material PCD definitely came too early.

In the early 70s to mid 70s, the question was what to do with a cutting material advertised by manufacturer General Electrics as a performance-enhancing material for machining non-ferrous metals. The “hard metal” cutting material had only recently been “defeated”. On top of that, non-ferrous metals – where were the potential customers asking for a cutting material for machining of aluminium, superior to carbide and with a much longer tool life? At the time, there was no automated production – microprocessors were not introduced into the world of machining until 1978, with one of the first turning machines. The material aluminium had to wait some time until its successful breakthrough into the world of motor manufacturing, in other words mass production of automobiles.

Not only the grinding of natural diamonds was “complicated” but also, and even more so, the grinding of “non-growing” polycrystalline diamonds. Therefore, the diamond experts were expected to deal with this “exotic” PCD.

This is more or less how it could have happened that we at LACH DIAMANT concentrated more and more, and with increasing interest, on this new cutting material. Due to our decades-long experience in manufacturing and service of turning tools, made of natural diamonds, for overturning copper commutators, for customers like Bosch, Siemens and AEG, we were made aware of manufacturing problems during the production of raw commutators – and the solution found in PCD[2].

Soldered PCD mount for external and outer turning and boring as well as for cutter heads.

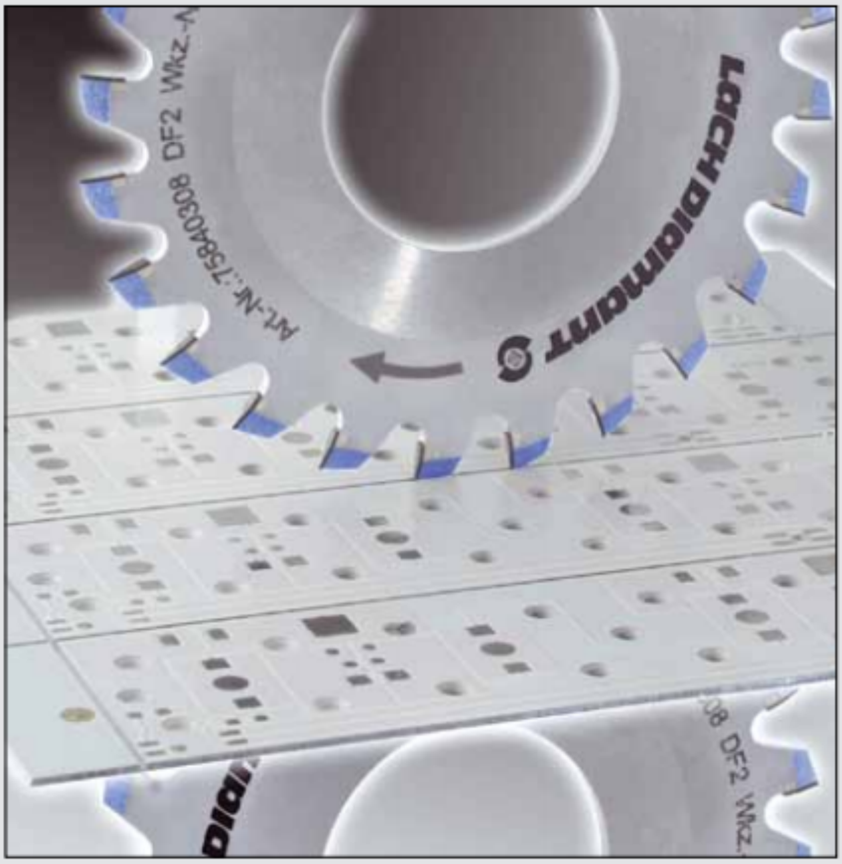
PCD tools had been developed based on the earliest requirements, and focused on the use of turning tools with soldered cutting segments with 60° or 90° angles.

Even though milling with PCD was already a highlight of the Hanover Trade Show in the spring of 1974[3], it was until the end of the 70s limited to carbide plates which were clamped into cutter heads. They consisted of a soldered PCD cutting edge and small shank tool with at the most 3 cutting edges.

We have to consider that all then available PCD cutting edges had to be tediously cut out of ø 3.4 mm, or at the end of the 70s, ø 6.4 mm blanks – which left only little scope for spectacular depth or width of the cuts. Furthermore, the prevailing textbook opinions about diamonds were still in too many heads during this phase: “Diamond is only suitable for polishing gold and silver and some non-ferrous metals – but by no means suitable for uninterrupted cuts”. Another obstacle during the market launch of polycrystalline cutting materials.

Convincing at productronica

Of all things, the announcement of a show , which was until then unknown to me, in hindsight proved to be a turning point for the implementation of polycrystalline



LACH DIAMANT »DreboBlueCut« PCD Scoring Saw – developmental status as of 2018 – "World Running Champion" not only during PCB machining but also (as shown in photo) during the scoring of aluminium IMS circuit boards.

diamond tools. The productronica, 1977 in Munich, announced as a component show for the electronic and circuit board industry.

I was interested. "Circuit boards? The basic material is glass fibre reinforced plastic (GRP), something we know." We had successfully cut this with PCD – even dust-free.

In order to demonstrate this successfully at the trade show, a demonstration machine was needed. We found it at former AEG in Seligenstadt where they manufactured circuit boards for domestic use: A Swiss machine from the manufacturer Amacher. Three processes could be shown on this small precision machine, type HAMBA: Cutting – Scoring – Edge Machining. Excellent. We registered for the show. We placed an internal work order for the three PCD tools or rather saws we needed.

The only objections were raised by production: "How are we supposed to grind these rotating tools – it will take forever…". Indeed, for example, to finish 12 teeth it actually took 35 hours of grinding time! But I thought – and I said it too – "You can do it – You always found a way in the past".

The productronica 1977 was at first a huge success for LACH DIAMANT – at the time there was a growing demand for electronic circuit boards, and all the big names were present and gathered around the small Amacher machine to marvel at the precise, highly accurate and dust-free machining of PCB , the basic material of circuit boards.

1977 at productronica in Munich – the worldwide first demonstration of PCD cutters, saws and scoring saws for PCB circuit boards on an Amacher precision machine, type Hamba.

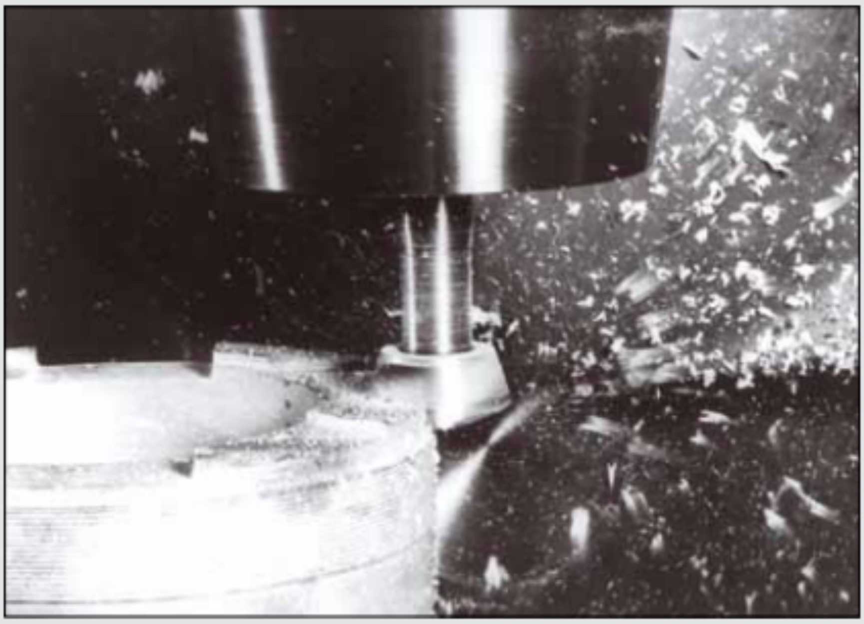
I still remember to this day, the doctors of Siemens and NCR who immediately thought of diamond saws for packet machining of 300 and 350 mm ø, and who spontaneously ordered samples for further experiments.

1977 at productronica in Munich – The first presentation of PCD tools for composite machining generated a great deal of interest.

It could have been so perfect. Machining of circuit board materials would have already been possible in a more efficient way since 1977, if… yes, only if the following would not have happened: "Boss, we really do everything for you, but we can only do one thing – either we can try to make scorers and saws for circuit boards, or we can continue to serve customers like Bosch and Kautt & Bux with commutator diamonds."

That was it for rotating PCD tools. The "grinding" technology delivered only 12 PCD teeth in 35 hours; the facts were very clear. The initial trade show success was gone. During the following twelve months, I personally had a very unpleasant task. The doctors or expert visitors at the trade show were really "hot" for this technology that had been successfully demonstrated. They assailed me with complaints that we were depriving them of this technology, for whatever reasons. In short: They were miffed.

In reality, the only culprit was this beastly polycrystalline "non-growing" diamond material itself; even diamond cutters with years of experience capitulated. Again and again we pondered how we could get results faster and and how to conquer this seemingly invincible stuff.



Chip generating PCD milling of glass fibre reinforced plastic (GRP) at experiment in 1974.

The Turning Point

And suddenly, at the end of 1978, a second turning point which would finally lead to success. Once again via an announcement, this time as a sales advertisement for a spark erosion machine by the company MATRA in a Frankfurt newspaper.

Never heard of it. Spark erosion machine? But I did remember my father mentioning that electricity played a role during the cutting of natural diamonds on the obligatory cast discs.

We had a good relationship with MATRA Frankfurt, at the time a manufacturer of “state-of-the-art” surface grinding machines. LACH DIAMANT was allowed to use these machines especially for experiments with CBN Borazon grinding wheels. “So, what” – I said to Gerhard Mai, our newly appointed master of PCD production, a former diamond cutter, trained at LACH DIAMANT. “Let’s take a look at this…”

We quickly made an appointment with the two gentlemen in charge at MATRA, Mr. Schreiber and Mr. Becker. “Yes, stop by with your extremely hard-to-grind carbide, we will see what we can do…”. A good thing that we had knowingly kept quiet about the fact that our so-called hard metal was PCD.

I clearly recall how Mr. Becker greeted us at the entrance and led us into a hall with rail access. Left and right of the entrance were some for me at the time un-identifiable machines.

We stood in front of a machine that I would call some sort of “sinking machine The PCD sample we handed over for the “spark test” was carefully mounted and disappeared in a “brew” which I now understand as a sort of dielectric. The power was switched on. I could tell from Mr. Becker’s face that he expcected our PCD to show a reaction. We took turns to examine the changes with a magnifying lens. Nothing happened – not even during the next five minutes. “Well, I am sorry, apparently nothing works with this carbide…” they said regretfully.

With the words “Okay, it does not work, it was worth a try”, we thanked them, and were already on our way out of the hall, when I suddenly discovered another machine in a corner. It looked slightly different, mainly because of an additional “tower-like” structure. “What kind of machine is this?” I heard myself asking. “A FANUC wire machine, it’s kind of similar” was the answer, “alright, since you are here already and if you want to try another experiment”.

“Let’s go over there, but I have to tell you right away that it contains a profile for one of our customers”. I only said “it doesn’t matter”. So the sample was mounted again – it immediately started to brew – and worked right away, in the truest sense of the word – the hot wire actually cut the promised profile out of the PCD – and formed it.

This visible success surpassed all our expectations. This “beastly material” had finally been conquered for the first time. And on top of that, this experiment had shown us how to produce profiling tools and mills under the influence of spark erosion. A discovery that would show its full value for the future only two weeks later… But first, I visited our patent lawyer on the next day – the patent number 0010276 “Herstellung beliebiger Profile in polykristallinem synthetischem Diamant mittels Funkenerosion” was granted and published on April 21st, 1982, as one of the first European patents. ***Horst Lach***

European Patent Nr. 0 010 276

Verfahren und Vorrichtung zum Bearbeiten eines polykristallinen synthetischen Diamanten und Verwendung des nach diesem Verfahren bearbeiteten Diamanten

Priorität: 13. Oktober 1978 – erteilt und veröffentlicht: 21. April 1982

Patentansprüche: (Auszug)

1. Verfahren zum elektroerosiven Bearbeiten von polykristallinem synthetischen Diamant, dadurch gekennzeichnet, dass zur Herstellung beliebiger Profile die Bearbeitung durch Funkenerosion erfolgt.

2. Polykristalliner synthetischer Diamant, hergestellt nach Anspruch 1, dadurch gekennzeichnet, dass der funkenerosiv bearbeitete polykristalline synthetische Diamant ein Profil einer Kreisscheibe oder eines Kreisausschnittes oder eines Kreisringes oder eines Kreisringausschnittes oder eines Rechtecks oder eines Ellipsenabschnittes oder einer aus diesen Konfigurationen zusammengesetzten Form aufweist.

3. Verwendung von durch Funkenerosion bearbeiteten polykristallinen synthetischen Diamanten als Schneiden in ein- oder mehrschneidigen umlaufenden Werkzeugen, vorzugsweise zur Bearbeitung von Hartholz oder Kunststoffplatten oder Spanplatten.