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LACH DIAMANT looks back on 100 years – 15th part

Poly – poly – or what?

Diamond contra diamond? A reflection on the versatility of 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 over 60 years of professional experience in the diamond tool business. This time he reflects on the versatile possibilities of diamonds.

Today, please do not expect a new thesis regarding diamonds as the (still) hardest of all things. Named after the Greek word Adamantinos, the unconquerable, natural diamonds grow deep below the surface of Mother Earth, under pressure and in high temperatures, and are then brought from the depth to the surface by humans

In the 1950's engineering ingenuity made it possible to recreate this natural process in synthesis. The manufacturer *General Electric* succeeded in cultivating the so-called "Man Made™" diamond under almost 6,900 bar atmospheric pressure and at 3,500° Celcius; a development which would lead to another industrial revolution within the quickly growing serial production industry.

We cannot imagine today's world without diamonds. Their hardness and invincibility make them a crucial cost-reducer for many tool applications in the industry – and their brilliance and everlasting beauty makes them fitting jewellry for our so much appreciated women.

It starts with gemstones

When preparing for the article "Diamond contra diamond?", in 2021, I immediately (regrettably) found information on diamonds as much sought-after gemstones. For example, no buyer of a polished diamond (brilliant) with a weight of half a carat (1 ct = 0.2 gram) would expect that he only has to pay "double the price" for a whole carat. The value is not only determined by size and purity, the buyer must also take the extreme rarity of finding large diamonds into consideration. For generations this was typical for the gemstone business with natural diamonds.

Of all companies, the "contra" aspect is now offered by a company formerly associated with "De Beers". Produced in synthesis, or "in the laboratory", the diamonds appear to have the purity of colour and clarity (factors of classification) of polished natural diamonds (brilliants); there is even a choice between white, blue or pink. And best of all: anyone, purchasing directly from this consortium, can calculate the price based on the carat weight from 0.25 to 2.0.
for example: the price for

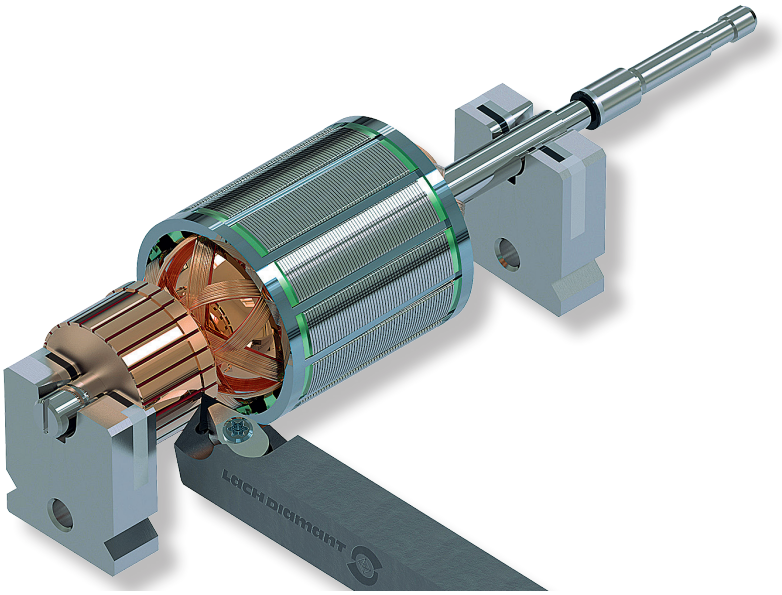
0.25 ct = 200 US $
0.5 ct = 400 US $
1.0 ct = 800 US $

et cetera, so that a 2-carat diamond would cost 1,600 US $.

The troubled sales people at the diamond exchanges in Antwerp and London and jewellers should know that all of these "laboratory diamonds" are marked as such with microscopically small imprints in order to prohibit "fraudulent" mix-ups with natural diamonds.

Diamond contra diamond – for example, natural diamond compared to polycrystalline diamond blades (PCD)

Diamond contra diamond; for example a single natural diamond dresser compared to a diamond dressing roll



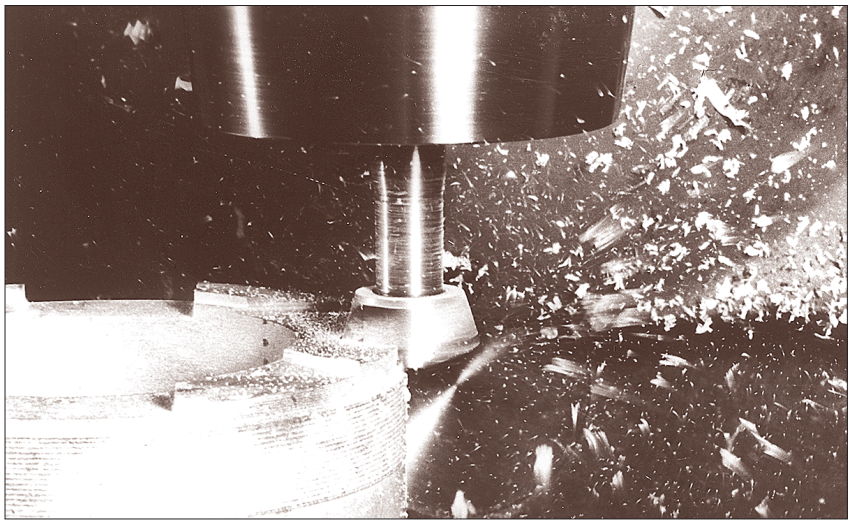
As early as 1973 polycrystalline turning tools replaced the overturning of copper lamellas of rough and fine polished copper commutators

Within the industry, the "contra" isn't playing out as drastically

In 1957 – after synthetic diamonds became first available – they were initially used as diamond grain for the development of new synthetic-resin bond diamond grinding wheels, and for the first time also for pre-grinding carbides. During the 1960's, 1970's and the 1980's a multitude of innovations swept over the market, some of which could only be implemented within the industry with certain delays.

What particularly comes to mind are polycrystalline synthetic diamonds (PCD), available since 1973. Simply put, they are synthetic diamond grains in a cylindrical shape which – under pressure and heat and combined with catalysers tungsten and cobalt – are pressed onto a round carbide plate (as a substrate), very similar to diamond synthesis.

The first PCD plates had a diameter of only 3.2 mm. However, when they were mechanically segmented into rectangles, they were the basis for the so-called PCD cutting tools, successfully presented by LACH DIAMANT for the first time at the Hanover trade show in spring 1973. With them, efficient turning machining of copper commutators (and their baked-in synthetic mica) was made possible for the first time.



PCD chip milling of glass fiber reinforced plastic (GRP) during an experiment in 1974 – compared to diamond-tipped tools, very little dust formation

Once again a new technology was born. Compact diamond blocks – PCD – were the basis for the development of cutting tools, superior to carbide tools, for "faster turning, drilling and milling with synthetic diamonds".

Turning of copper commutators is another "contra" argument in this reflection. Until the use of the first PCD *dreborid*® turning steel, copper commutators were turned exclusively with natural diamonds during fine polishing. With the result that I had to take my first car to the repair shop every 750 km to have the wiper motor exchanged; otherwise, the wiper could have failed during the next rain.

And today? Problems with windscreen wiper motors? No thank you. PCD turning means they should last multiple car-lifetimes.

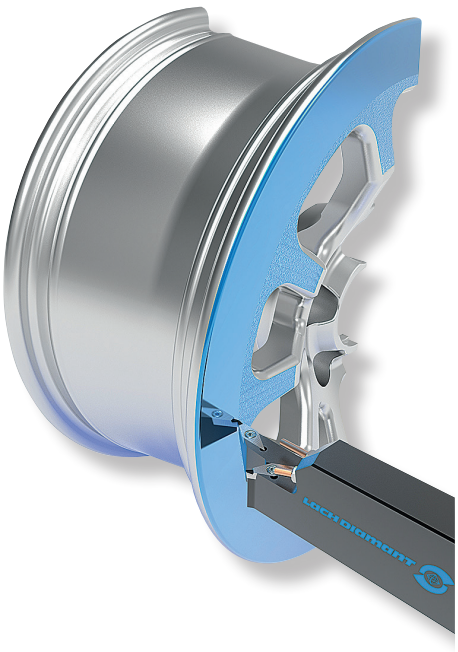
A similar "contra" – clearly in favour of PCD – can be reported of turning motor pistons. Until the 1970's I could observe high class automobiles broken down by the roadside when I was driving to the Hanover trade show, apparently due to piston seizure. At that time expert drivers were convinced they had to "breake in" their brand-new cars on this route. If the motor could stand it, it was a good car…

The introduction of polycrystalline cutting tools in the aluminum processing automobile industry also uncovered this "contra" in piston manufacturing as well as the insight, that the surface quality achieved during turning with polycrystalline cutting materials – instead of the thus far used natural diamonds – allowed for a perfect lubricating film which immediately prevented piston seizure to the greatest possible extent.

Another argument in our reflection on "diamond contra diamond" brings composite and wooden materials and their respective industry into focus.

Indirectly, carbide is partially involved in this example of "contra", since diamond is also present in the grinding wheel for carbide: pars pro toto.

Early on, after the successful use of PCD turning, drilling and milling tools, other non-ferrous materials, such as aluminum and



PCD tool during front facing of an aluminum rim

A diamond cut-off wheel, electroplated with diamonds during the cutting of a GRP (glass fiber reinforced plastic) component

copper as well as some plastic materials were tried in experiments. Examples are soft and hard plastics, glass fiber and carbon fiber materials, electrographite carbons and miscellaneous wooden materials.

The photo on the previous page was taken during these adventurous times. It shows a PCD end milling cutter during the chip machining of a GRP component.

When the second productronica was held in Munich in 1977, PCD tools for sawing/scoring/milling/drilling were demonstrated to an astonished audience on an *Amacher* electronic circuit board machine, which had been purchased especially for this purpose. It was so successful that for the time being – until the discovery of spark erosion – expectations of the relevant industry had to be disappointed.

Other industries had now become just as curious and further experiments and construction continued diligently. For example, machining of carbon fiber components for the aircraft industry, which in turn should initiate revolutionary successes in the development of spiral drills, especially for one manufacturer. And a real "contra" should become clear during the machining of composite materials. A *pro and contra* for some imminent problem solutions. While using the same diamond material, different production and tool technologies created controversies. For the first time, PCD tools and the already "tradition-rich" diamond-coated electro-plated tools were in competition with one another.

Special advantages of electro-plating

Almost all profiles projected onto steel bodies can be coated with diamond and re-coated after wear in service. The diamond grains applied to the surface of the steel body allow good removal rates – depending on grain size – which is especially advisable for deburring tasks. They are versatile in use, like cut-off wheels up to high diameters, or for cutting GRP and other hard materials.

The disadvantage: dust formation which must be extracted. LACH DIAMANT provides a special solution for hollow drills, featuring extraction directly at the tool.

Special advantages of PCD

As far as the geometries of the composite component to be machined allow, turning and milling operations can be performed efficiently and without any problems, and can therefore be recommended accordingly. Profile and drilling tools can constructively be equipped with PCD cutting edges, which is especially advantageous for larger production numbers. Further advantages result in comparison with electroplated diamond tools, e.g., grooving tools with exact tolerances for corners and radii for serial production. Chips, produced during machining, can be extracted very well. PCD blades can be reground several times.

Diamond tools have become an intrinsic and valuable part in the world of technology, especially during the last 50 years. The list of examples above could easily be extended – innovative spirit and (positive) thinking outside the box will continue to enrich "pro and contra" in many industries and many applications. For example, let's think of the natural diamond as a single tool for dressing and profiling of grinding wheels – it was replaced as a single point dressing tool by a chain of innovations in serial production. Roughly in the order of the following developments: by the multi-point dresser, the *Diamant-Fliese* or rather dressing plate and – up to date – by diamond dressing rolls.

When we focus at last on the diamond itself, we wonder whether it will really stay the hardest of all things? Personally, I am not so sure about that. A "contra" could be in the making here too. Recently the press featured a "glass" which supposedly could score even the surface of a diamond…

Horst Lach

further information: ***www.lach-diamant.de***