CBN grinding wheels

Cubic Boron Nitride, CBN known by the acronym of General Electric and ABN under the symbol from the Van de Beers is a material such as hardness is second only to diamond. It is used in the manufacture of grinding wheels in two different ways: by electro-deposition of the grains on a metal body or by including the grains in a ceramic matrix.
The first type of grinding wheel has a fixed profile and is not possible to dress it, that is, it uses up to wear and then sends it to the manufacturer for a further coating with CBN.
The second type allows the dressing and changing the profile, resulting in a total greater efficiency and, in specific conditions, a lower cost of the grinding operation.
The electroplated CBN grinding wheels are generally suitable for production of large and medium series, where the profile of the piece, and in particular on the gears, is the same for a large number of pieces.
The ceramic CBN grinding wheels of the contrary are suitable for smaller series where there is a need to change the profile with a certain frequency.
Recently it has increased the use of materials difficult to machine, the tolerances are tight, they require more and more accurate surfaces and production times ever lower. The machine tool industry has put in the market machines tool increasingly powerful, fast and precise in same time the abrasive technology has made great progress.
The Cubic Boron Nitride in the electroplated grinding wheels and in the grinding wheels in CBN with ceramic bond is increasingly present in the grinding operations because it allows shorter cycle times and allows “cold” cutting to avoid problems of variation of the surface structure of the material being processed.
It should be noted that the CBN grinding wheels and metallic bond can be of two types as is clear from figure N°1, that is, the first obtained by a process of electro-deposition, the second with a sintering process. In the first case there is only one layer of abrasive grains usually bonded by a nickel alloy, in the second case the grains are smaller and can be bonded with ceramic materials (V), resin (B) or metallic (M).

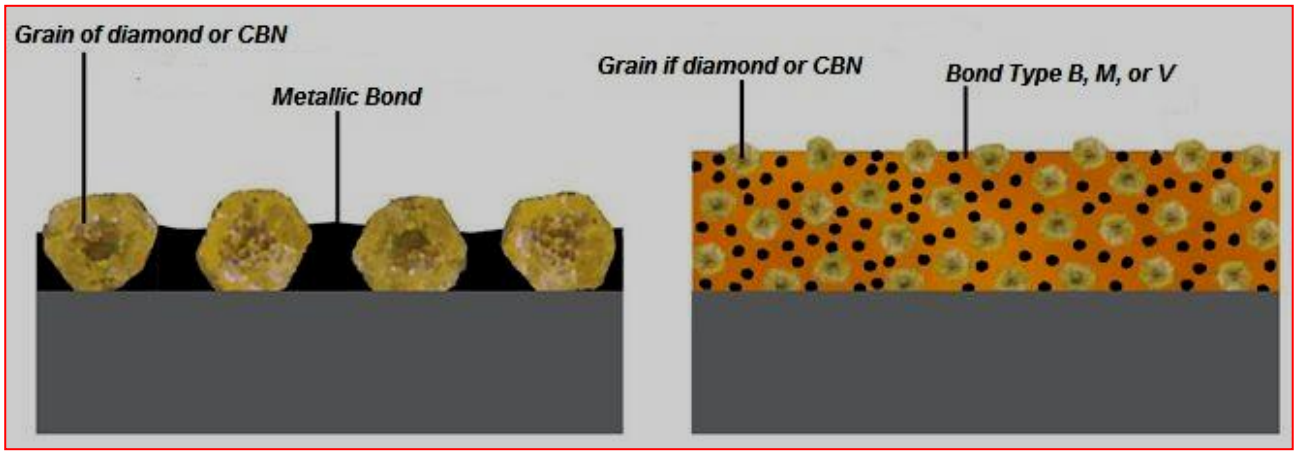

Figure N°1

Unlike grinding wheels with metallic bond, the ceramic can be produced with a controlled porosity.
The spaces between grain and grain can be sized so as to optimize the removal of chips and heat, facilitating the flow of coolant in the contact area. This is the reason why it has a lower concentration of heat in the area where the chip is detached and the risk of burns are drastically reduced.

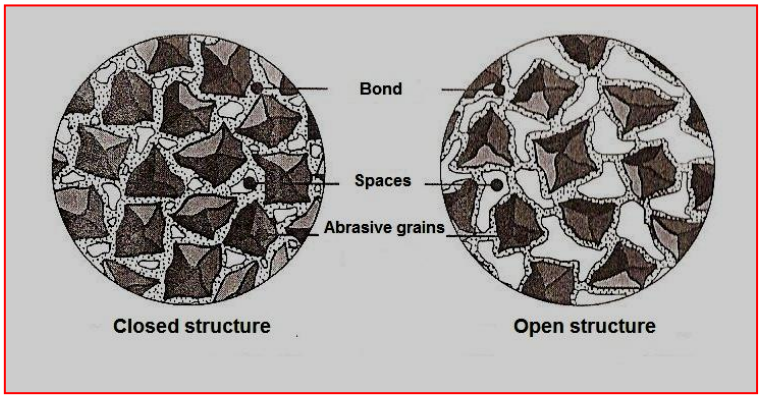

Figure N°2- *Examples of structure of CBN grinding wheels*

Figure N° 2 schematically shows a closed structure and a open structure and you immediately realize that the open structure allows easier penetration of the abrasive grain on the surface to be ground, improving cutting efficiency.
It is also evident that the great hardness of the CBN grains can perform a number of much larger pieces than an aluminum oxide grinding wheel, before a dressing operation.
It must be said that the cubic boron nitride crystals are formed at pressures ranging from 50,000 to 90,000 Bar and temperatures from 1800 °C to 2700 °C, ie pressure and temperature fields very large then the characteristics will vary notable. Synthetic diamonds are produced at pressures from 70,000 to 120,000 Bar and temperatures around 2000 °C.
There are various types of CBN crystals with different characteristics, not only, but the individual crystals may also be subject to a special treatment in order to exalt some particular properties.
For example, are used CBN grains coated with titanium that isolate the grain from heat. This coating works like a kind of bypass in the transmission of heat. But what most differentiates the grains are their shape and their hardness. The various types are distinguished by their color, as shown in figure N° 3.

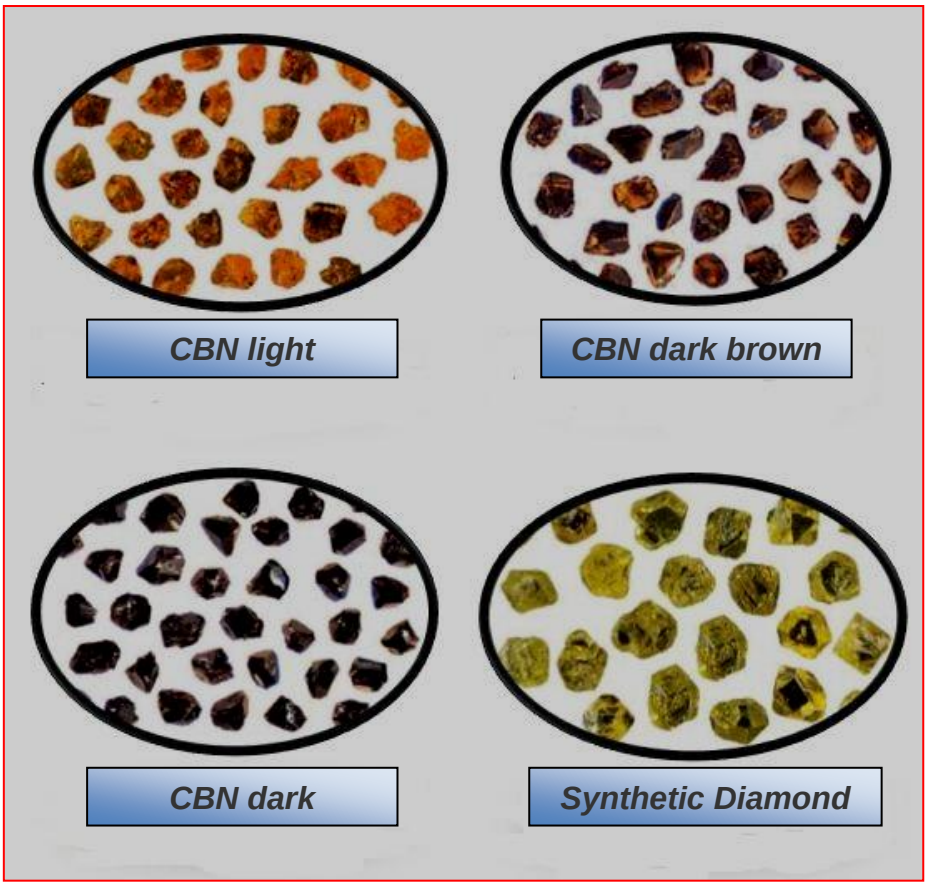

Fig. N°3- *Some example of CBN grains*

In summary we can say:

- *CBN light*: geometrically irregular, medium hard. Suitable for every use.
- *CBN dark brown*: very thermally stable, suitable for machining hardened steel with poor machinability.
- *CBN dark*: high hardness. Suitable for internal grinding of hardened steels.
- *Synthetic Diamond*: suitable for processing hard and fragile materials such as sintered carbides, glass, ceramic, granite.

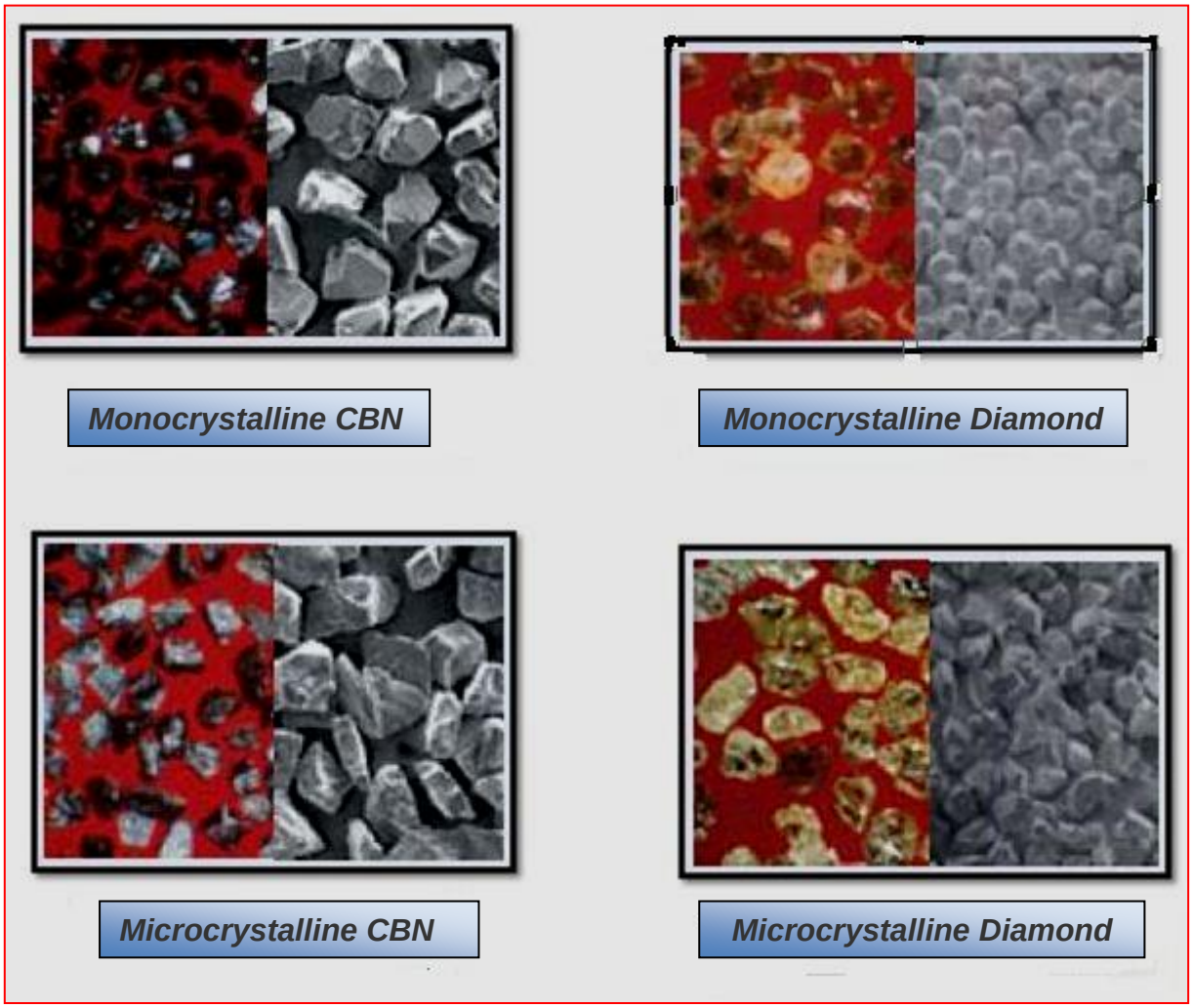

Figure N°4- *Various types of crystals in CBN and in Synthetic Diamond*

The crystals of synthetic diamond and CBN also differ in their structure. The most commonly used is the single crystal, which breaks under a high pressure of work exposing new sharp edges, that has some ability to self-regenerate.
The other type is the microcrystalline CBN, where each grain is composed of particles smaller than the micrometer. See figure N°4.
The characteristics of a CBN grinding wheel under the terms of removal capacity, the maintenance of the profile, and surface quality obtained, are defined by the following parameters:

- *Grain size*
- *Concentration*
- *Hardness*
- *Structure*

Grain size
The larger size, a coarse grain, allows faster material removal of the material while a finer grain allows for better surfaces.

Most applications use the grains between 76 and 151. The grain size is identified by a number fixed by FEPA standards according to the following table:

The grain size in µm for Diamond and CBN in according to FEPA and DIN and comparison with other standards

Diamond FEPA DIN 848	CBN – FEPA DIN 848	Nominal width of the mesh (*µm)* ISO 565	USA - ASTM E11-70 (Mesh) Mesh per 1"	Japan JIS 6002-63 size *µm*	Russia Gost 3647–71 size *µm*
D251	B251	212 – 250	60 – 70	250 – 210	250 – 200
D213	B213	180 – 212	70 – 80	210 – 177	250 – 200
D181	B181	150 – 180	80 – 100	--	200 – 160
D151	B151	125 – 150	100 – 120	149 – 125	160 – 125
D126	B126	106 125	120 – 140	125 – 105	125 – 100
D107	B107	90 – 106	140 – 170	--	100 – 80
D91	B91	75 – 90	179 -200	105 – 75	--
D76	B76	63 75	200 – 230	88 – 63	80 – 63
D64	B64	53 – 63	230 – 270	--	63 – 50
D54	B54	45 – 53	270 – 325	53 – 44	60 – 40
D46	B48	38 – 45	325 – 400	44 – 37	50 – 40
---	B30	40 – 25	--	--	40 – 28
D25	--	52 - 32	--	--	--

Hardness of the grinding wheel

The grinding wheel, according to its hardness, is suitable for a specific process.
Soft grinding wheels are more suited to processing of materials or parts that may change if temperature increase. While the hardest grinding wheels are most suitable in those processes where it is necessary to maintain the constancy of the profile.
The hardness of the grinding wheels is indicated by a letter from B (very soft) to X (very hard). In vitrified CBN grinding wheels are identified:

- *Soft grinding wheels : N, O, P*
- *Hard grinding wheels : Q, R, S*

Softer grinding wheels are suitable for to grind pieces that can change the shape or structure under the influence of local heating. The hard grinding wheels are used where is required a good constancy of the profile.

Concentration

Concentration is the ratio of the weight in carats of the CBN, where the carat equals 0.2 grams, and the weight of a cubic centimeter of binder. The concentration affects a lot on cutting capacity and the possible production between two dressing of the grinding wheel, but obviously also affects its price.
The concentration is identified by a number corresponding to a certain amount of CBN as in the following table.

Concentration	Carats/ cm^3
50	2,2
75	3,3
100	4,4
125	5,5
150	6,6
175	7,7
200	8,8

Structure

In all grinding operations, both with ceramic grinding wheels and with CBN grinding wheels, the structure has a critical role in the operation in order to obtain a good result and a high efficiency. Open grinding wheels with artificial porosity are indicated for high

performance grinding operation. The level of structure is indicated with a number as in the following table:

CBN standard structure						*CBN porous structure*		
closed		*open*		*medium*		*medium*	*high*	*very high*
1	*2*	*3*	*4*	*5*	*6*	*15*	*16*	*18*

Summary of the various types of binder

At the beginning of these notes, has already said something about the type of binder in CBN and diamond grinding wheels and . Here you do a quick summary of this topic.

- *Vitrified bond*

Also called ceramic bond. It has several advantages in almost all grinding operations where high accuracy is required. The structure of the grains and the matrix of the bond allows for easy dressing and grinding wheel reconditioning, ie to a change of form. The vitrified bond is tough and durable, which makes the wheels of this type very efficient in terms of life and maintain its profile. The vitrified bond has a porous structure that promotes the flow of refrigerant and prevents clogging of the chips.

- *Resinod bond*

Phenolic or polyamide resins are used to block the grains of CBN or diamond. The grinding wheels of this type are fairly sharp but to be dressing frequently with a little bar of aluminum oxide. With the use of different binders can vary the hardness of the wheel.

- *Metallic bond*

The first type is electroplated with nickel. These wheels are less expensive than the previous ones, but have only one layer of abrasive when their duration is shorter.
The grinding wheel is very aggressive and removes more quickly.
The other type, as shown in figure N°1 is the type with sintered metal bond. The metal binder are extremely compact and much harder than resin bonded grinding wheels. They tend to heat up and should always work wet.

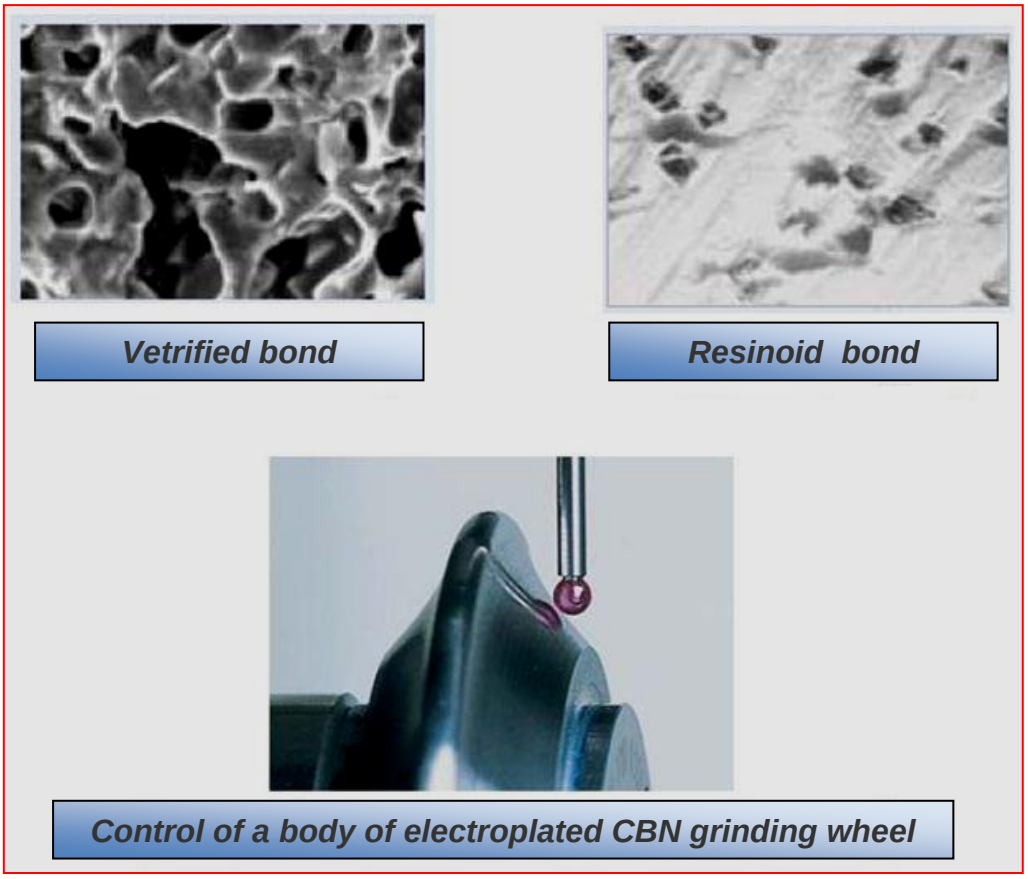

Figure N°5