ANNALS of the ORADEA UNIVERSITY.
Fascicle of Management and Technological Engineering, Volume VI (XVI), 2007

WORKING PROPERTIES OF DIAMOND

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Keywords: Diamond, working properties, crystaline shape.

Abstract: The actual work presents the working properties of diamond: physical and mechanical properties,

1. INTRODUCTION

The word "diamond", comes from the Latin word "adamas, adantis", which means indestructible.

Diamond is of two kinds: the natural diamond – produced entirely by nature – and the synthetic diamond – produced in industry. The letter, have the same properties as the natural diamond.

Natural diamond is found at considerable depth in the ground, on the bottom of the sea or in alluvial deposits.

Diamond has different colours according to the purity degree. That is, if diamond is pure or almost pure its' colour is white or bluish-white. If diamond is impure – represented by oxides, its' colour is light or dark brown – because of the buffing ochre – or green – because of the cupric oxides.

Generally natural diamond presents itself as a monocrystal, formed of carbon atoms. In diamond's mass is included a very or almost small quantity of impurities. Diamond's quality decreases when the quantity of impurities included in diamond's mass, increases.

The evaluation of raw diamond is made according to weight calculated in carats, to clearness and also according to the possibilities to be cut and polished.

It is always crystallized in the cubic system that has 3 equal and perpendicular axes. The distance among the cube's edges is 3,566 A.

Morphologically, the diamond may have an octahedral, a decahedral, an exaoctohendral or a rhomboid form and rarely other forms. Usually, diamond crystal morphology is situated between the almost cubical form and the octahedral form. The main form is the cubical one.

In the field of study, "Diamond Innovation", has settled a new diamond measurement technique by means of a new parameter called "tau". For the cubical form, "tau" has the value 1 and for the octahedral form "tau" has the value 0,0.

The cubical diamond form is the joining of two cubical networks with horizontal shifted centered faces with a quarter from the unitary cube's diagonal.

Its' crystalline structure is very compact. Diamond contains 18 atoms of carbon: 8 are being placed at the corners of the cube, 6 atoms at the faces of the cube, 4 atoms are being placed in the center of four of the 8 frames that result from splitting the cube into planes reciprocally perpendicular.

In the center of the cubic network, each atom of carbon is strongly connected to the other 4 adjoining ones.

Diamond is characterized by special optical, chemical, physical and mechanical properties:

1. Physical and mechanical properties:

a. density	$9/cm^2$	3.48 …3,56
b. microhardness	H daN/mm^2	10000
c. Mahs hardness		
d. the elasticity modulus	E daN/mm^2	90000
e. the compression resistance	Gpa	2,5…5,0
f. traction resistance	Gpa	0,4…0,5
g. bonding resistance	Mpa	600…800
h. brakeage mechanic work	I/m^2	130…160

2. Mechanical properties:
   a. diamond may burn if it is heated at red with a burner;
   b. it resists to acids and their alkaline;
   c. it resists to fat acids such as those found in the beauty creams and parfumes;

3 Optical properties:

It has a refraction coefficient superior to transparent natural stones. It has the value 2,44 in violet and 2,41 in red. Diamond has s refraction coefficient inferior to siliceous (3,42) in its' transparence domain.

3. Thermal properties:

a. so far as $1oo^0$ resistance at thermal shocks;		
b. excellent thermal conductor	W/m^0C	50…100;
c. thermal stability	^0C	1000…1200;
d. linear dilatation coefficient	$I/grade.\ 10^{-8}$	0,9…1,45.

Diamond is a good electrical insulator.

Resistance forms the main characteristic of diamond as the toughest material known. Diamond's hardness is shown at both high and low temperatures.

Diamond's hardness is not identical in all directions - the anisotropy property. That's why "smooth" and "tough" directions exist. This aspect must be taken into consideration when using diamond in working tools construction.

The extreme hardness of diamond provides very small friction coefficients. At the same time, this characteristic permits the increase of the cutting capacity and of the wear resistance of the working tools blades.

Another important property of diamond is its' mechanical resistance, which powerfully influences diamond use in cutting tools exploitation domain. As in the case of diamond's hardness, the values of the mechanical resistance depend on the anisotropy property of diamond. Referring to this, diamond has a low resistance level at shocks, crushing and bending.

As opposed to this, diamond has a high level of elasticity as compared to the borine, siliceous and metallic carbides and influences the cutting properties of the diamonded tools.

Diamond has the highest thermal conductance as compared to the metallic carbides and the rapid steel and at the same time the smallest expansion coefficient.

These properties give diamond resistance to the thermal stress generated by the cutting process.

Taking into consideration the mentioned properties of diamond, the fallowing must be seen when using diamond in working tools exploitation:

1. When processing ferrous metals, at nearly 800 degrees Celsius, appears a so-called graphitization of the exterior parts of the diamond crystals as a result of the diamond capacity to diffuse solid solutions within the spatial network of the iron atoms. As a result, a damage of the diamond’s granules blades takes place. As a mean of protection from the mentioned phenomenon, the cooling of the diamonded part of the cutting tool is necessary;

2. The possible dissolving of diamond by other metals at high temperatures.

Taking into consideration the aspects presented above, diamond is used to fabricate the next products:

- Aluminum alloys
- Copper alloys
- Abrasive plastics
- Glass and carbon fiber composites
- Green ceramics
- Tungsten carbide
- Abrasive wood/plastic composites
- Natural stone

Concrete, industrial diamonds may be classified according to two criteria:

a) The obtaining mode

b) The utilization mode.

According to the first criterion, diamonds are of two kinds:

1) *Natural diamonds*;
2) *Synthetic diamonds*.

The fabrication of synthetic diamonds is quite simple. They are obtained from pure graphite at high temperatures and pressure.

According to the second criterion, diamonds are classified into:

1. monocrystals, delivered in different shapes and measures – usually between 0,3 and 2 carats (1 carat = 0,205 g) and rarely between 6 and 8 carats;
2. polycrystals (diamond’s aggregates)

Industrial diamonds are obtained from natural or synthetic diamond’s granules sintering (with measures between 0,1 and 0,02 mm). Industrial diamonds are realized at high temperatures and pressure in two ways:

a. the sintering made in metallic bond mass (cobalt). The obtained polycrystals are delivered in form of prismatic pills with different sizes and shapes;

b. the direct sintering of graphite in presence of different solvents. The obtained polycrystals (Carbonado and Ballas types with different versions) are delivered in cylindrical form with different thickness. Diamond polycrystals have important mechanical and physical properties, such as microhardness, synthetic and dynamical resistance, wear resistance, thermal resistance, the isotropic property as a result of the plycrystaline construction, the lack of plane cleavage etc.

These properties give them a large use in the cutting tools construction and exploitation: finishing and roughiong working at aluminum and its’ alloys, cuprum, bronze, brass, zinc and alloys, titan alloys, nonmetallic materials such as glass, graphite, ebonite, resin.

Synthetic diamond polycrystals provide law friction coefficients when working metals and leads to a decrease of the cutting forces and also to minimal plastic deformations of the worked peace’s splinters and superficial layer. It also may be noticed that as compared to natural diamond, the synthetic one has a different mechanism for the tool wear performance, namely it is realized by means of crushing a small part of the diamond. As a result, the wear resistance increases from 1.5 to 2 times;

3. Metallic powders. These are obtained by crushing the industrial diamond mono and polycrystals that can't be used in cutting tools construction because of some cracks or because of not taking into consideration the size and form conditions for industrial use purposes etc.

Diamond powders are classified by their granulometric composition.

Generally, industrial diamonds – because of their important mechanical and physical properties – are largely used to construct machines and especially in the cutting tools construction and exploitation.

4. CONCLUSIONS

Diamond is characterized by special optical, chemical, physical and mechanical properties. Resistance forms the main characteristic of diamond as the toughest material known. In mechanical working both natural and synthetic diamonds are used. The worked materials range is very large: aluminum alloys, copper alloys, abrasive plastics, glass and carbon fiber composites, green ceramics etc.

In conclusion diamond is a very important material with a huge domain of usage.

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