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Characterization of an Abrasive Tool in Agglomerited Corundum and Determinition of its the Lifespan

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Abstract: The compacts carried out in the form of pastilles (of diameter 18×5 mm) according to the process of the products sintered in the presence of an abundant vitreous phase. The mixture compressed uniaxialement cold consists of an abrasive powder in Al_20_3 and a vitreous binder containing kaolin, feldspar plagioclase and quartz α. Among the constant parameters of grinding: Compactive effort, the temperature of cooking and duration period. The required characteristics are: Porosity, lifespan and the proportion of the components.

Key words: Alumina, compression, characterization, density, porosity

INTRODUCTION

The grinding of optical glass is influenced by a certain number of parameter; the powder of corundum in suspension can be replaced by agglomerated abrasive tools. Pastilles out of artificial diamond gives satisfactory results like were checked by Konig and Koch (1989) but cost more.

We propose in this study the results of elaboration of a pastille starting from a corundum powder to improve the effectiveness. That this depends on the granulometry, the type of binder and the pressure of compaction as well as temperature of cooking. The mechanisms of elimination of porosity are studied on a powder Al_2O_3. One foresees through work of Parks and Evans (1994) the prospects offered by the new tools for manufacture for the optical components and of mirrors of telescopes.

MATERIALS AND METHODS

Materials: The tests are carried out on a Al_2O_3 powder to 98,3% of purity, its granulometry is about 10 μm, with a hardness of 9,5 on the Mohs scale of hardness, a density of 3,89 g cm^{-3} and a melting point of 2050°C. The examination of the Al_2O_3 grains using an optical microscope (NEOPHOT), of resolution 0. 2 μm and maximum inaccuracy ±0.1 μm, allowed us to observe angular forms slightly lengthened with multitudes of stop sharp. It is advised by Raffino (1978) to examine at least 200 grains per fraction. These grains are agglomerated using a vitreous mineral binder containing kaolin, of feldspar and quartz, of granulometry <5μm, employed by the ENAVA-to obtain a composition presenting a sufficiently dampening liquid phase at a rather low temperature.

Elaboration of pastilles: During the elaboration of the pastilles, several parameters influence its quality and its effectiveness. Obtaining an adequate combination allows to elaborate pastilles with better properties. The constant parameters of elaboration are: the compactive effort, the temperature of cooking the time of maintains. The only parameter variable to study is the proportion abrasive-binder. Our study is carried out on the Combinations (C): (C I)-70% abrasive 30% binder; (C II)-65% abrasive 35% binder, (C III)-60% abrasive 40% binder. A mixture of 80 g enables us to work out 18 pastilles; the homogenization of the mixture is carried out with a crusher with porcelain ball hang 90 min and controlled by means of a microscope. In order to obtain a pasty mixture, each 5 g of pulverulent mass will be wet by 50 mL acetone and will be mixed. The density and the resistance of the vintage are influence by the humidity of the paste. That is compressed uniaxially plain with a steel alloy tool resistant to chromium 13% soaked, with a play (matrix- punch) of 0,1 mm, on a hydraulic press (type PYE 63S) generating an effort going until 60MPa, the effort applied, during the compaction is of 3,15MPa.

The pastilles are exposed to the free air during 24 h to evaporate acetone. Then carries out their cooking with 1200°C reached in 6 h and maintained during 90 mn with the stage of fusion of the binder studied by

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Mansouri *et al*. (2006). Cooling is carried out with the furnace hang 18 h. It was confirmed by Kingery *et al*. (1961) that during cooking vitreous flow practically does not dissolve alumina, which means that the abrasive grains keep their properties after cooking.

RESULTS AND DISCUSSION

Characterization of powders

Mineralogical analysis: The mineralogical analysis of the components by spectroscopy with x-ray fluorescence (type siemens SR ZO_3) gave the results presented on Table 1. It made it possible to identify some impurities of the corundum powder. Another experiment was carried out on the F10 fraction like on the flexible powder (binder) using a diffractometer has x-ray (type APD 1700), at the laboratory of the EREM. Figure 1 and 2 shows spectra X-ray obtained.

Density of powder: The specific surface of grains was measured with the apparatus of Blaine of constant K = 34.1842, calibrated with a volume (Vet.) of 1,7652 Cm^3, at the temperature de16°C and whose cell weighs 96.9354 g vacuous. Then, we carry out the measurement of the weight of the cell filled with slightly packed powder and of the time of descent of the water column T (S). The irregular morphology of the grains strongly increases their specific surface, which can be calculated by the relation (1). Table 2 illustrate the results of measurement.

$$S = \frac{K\sqrt{P^3.t}}{\rho(1-P)\sqrt{\eta}} \qquad (1)$$

$$P = 1 - \left(\frac{m}{\rho.Vet}\right) \qquad (2)$$

With: P- porosity of the packed layer of the powder calculated by relation (2);η- density of the grains (3.89 g cm^{-3}); T(sec.)- time of descent of the water column. (Table 2); ç- viscosity of the air in poise with 16°C; $\sqrt{\eta} = 0.01337$; m masses powder.

Table 1: Chemical composition of raw materials

Powder Al_2O_3		Binder	
Minerals	Content %	Minerals	Content %
Brown corundum (α Al_2O_3)	98.30	Quartz	41.81
Quartz α	01.11	Kaolinite	38.20
Hematite (α Fe_2O_3)	00.38	Feldspar plagioclase	18.20
Other	00.21	Hematite	01.54
/	/	Mica, pyroxene, other	02.25

Characterization of the elaborated pastilles

Density and porosity of the pastilles: The density must be uniform through all the volume of the pastille which can be calculated by the relation: d = ρ = m v^{-1}; with: d- density, m- mass, v- volume. From where we can draw the porous Percentage (P) of the pastille calculated by the relation (3):

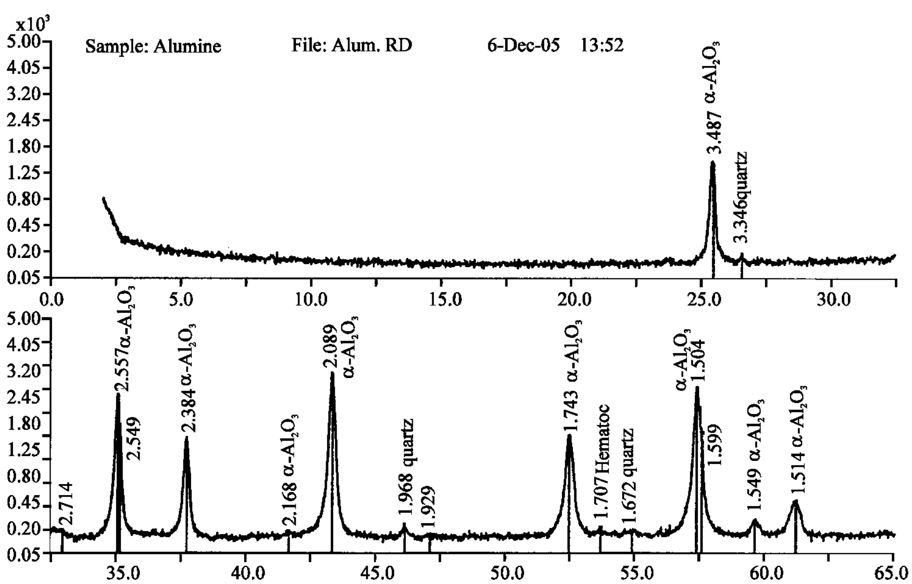

Fig. 1: Specters RX obtained from some powder corundum

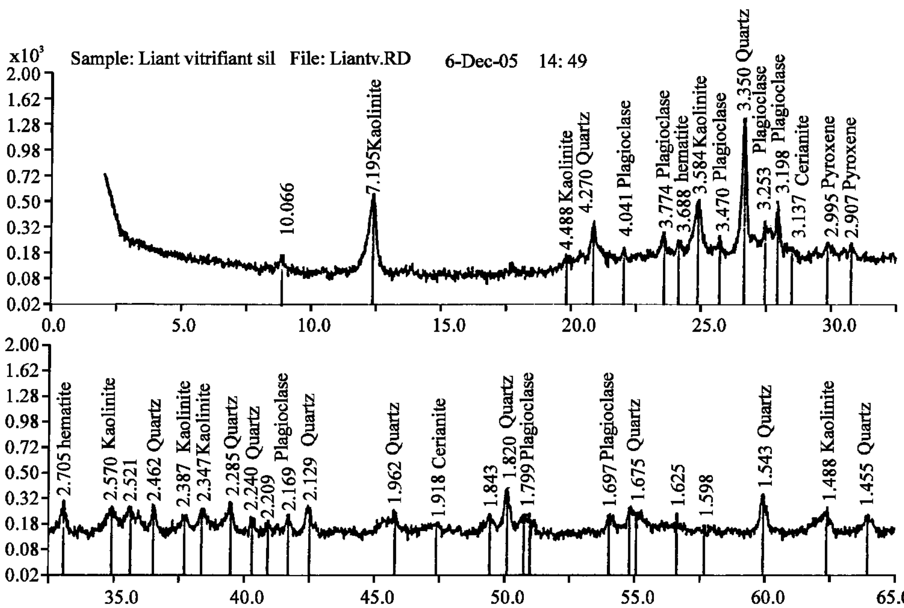

Fig. 2: Specters RX obtained from the binding {*connecting*} powder

Table 2: Characteristic parameters of powders

Parameter	Unity	Powders F.10	Powders F.14	Powders F.28	Powders F.80
Time of descent of water	Sec.	20	18	11	4
Weight of the powder	g	3.3504	3.3504	3.16	4.3056
Weight of the cell filled	g.	100.2854	99.6854	100.0954	101.241
Specific surface	$cm^2\ g^{-1}$	3955	1855.4	1119	361.16

Table 3: Density of the pastille of the various combinations

Combinations	d (mm)	e (mm)	m (g)	v (mm^3)	ρ ($g\ mm^{-3}$)
C.I	17.973	6.772	4.289	1717.227	2.497
C.II	18.239	5.754	3.875	1502.594	2.578
C.III	18.910	5.763	4.189	1617.712	2.590

Table 4: Characteristics of the pastille of the different combinations

Combinations	ρ'	ρ	Porosity %	Compression resistance (N)	Hardness rockwell	Hardnes vickers
C.I	2.211	2.457	10.07	> 10 4	75.4	98
C.II	2.270	2.578	11.94	> 10 4	69.5	78
C.III	2.329	2.590	11.45	> 10 4	80.3	117

$$P = \frac{1-\rho'}{\rho} \qquad (3)$$

With: P and P^1-Density of compressed and the mixture.

Measurements of the diameters and thicknesses of pastille as their density were taken under microscope. Table 3 presents these results. Density of the powder at summer measured with a pycnometer in order to deduce the porosity of the pastille the data by Table 4.

Quality and efficiency of pastilles: We fixed on a cast iron disc of diameter of 90 mm 08 pastilles using a resin, their densest surfaces is in contact with the standard sample of glass (LF7) which is animated in two rotational movements, n = 450 tr. mn^{-1} and oscillation with an

Table 5: Mass removed for the various combinations

Grinding (Tr / mn)	30	60	90	120
Δm (C.I) mg	6	10	30	50
Δm (C.II) mg	10	20	35	55
Δm (C.III) mg	10	29	50	60

amplitude of 1cm and sprinkled by 50 mL min^{-1} of water. The interval of grinding of 2 min is carried out at a temperature of 20°C; the characteristics sought for the tools under tests are: optical surface quality that it carries out, its effectiveness and wear according to the time of manufacturing.

Efficiency and quality of surface (sample): The quantity of removed matter characterizes the degree of effectiveness of the pastilles. $\Delta m = m_0 - m_1$. Measurements

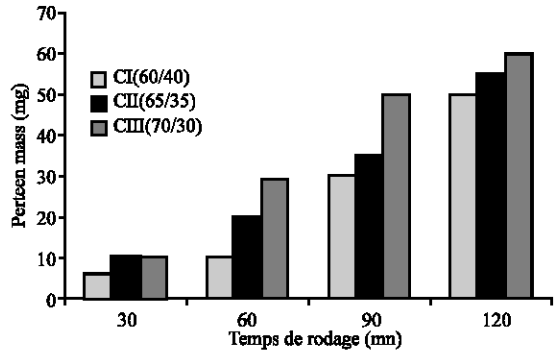

Fig. 3: Mass removed according to time

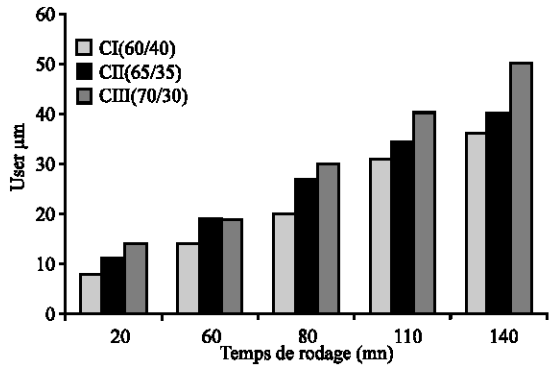

Fig. 4: Wear of the tool according to time

Table 6: Decrease of the thickness of the tool during the grinding

Time of grinding (mm)	20	60	80	110	140
Wear (C.I) mg	8	14	20	31	36
Wear (C.II) mg	11	19	27	34	40
Wear (C.III) mg	14	19	30	40	50

Table 7: Lifespan of the tool of grinding

Combinations	Lifespan (number of phases)
(C.I)	2870
(C.II)	3990
(C.III)	3675

were taken with a balance of precision of 0.1Mg, whose results are represented on Table 5. The histogram of Fig. 3 illustrates the effectiveness of the pastilles.

Wear of tools (pastilles): The lifespan of the tool of grinding can be studied by its wear. Table 6 represents the reduction thickness during grinding for the various combinations according to the time of grinding. Measurements are taken on three points with 120° from the pastille using a measurer of ABBE. Figure 4 shows the comparison of the wear of the pastilles. The lifespan of this tool depends also on grinding's number of phases as Table 7 shows it.

CONCLUSION

According to the various results obtained, we note that the wear of the pastilles during the grinding of the various combinations is done regularly according to the time of grinding. By comparing the effectiveness of the various combinations, the second is that to choose seen his best report/ratio lifespan - speed of removal. Indeed, for a low content of binder the detachment of the grains with edges not completely worn is done more easily, leaving place to another layer of grains with arises. On the other hand, for the tools with strong content of binder the detachment of the grains is done only after their complete wear. It is noted that the removal of the matter is regular according to the time of grinding. It is also noticed that with the third combination the speed of removal is highest considering its strong content of abrasive with a maximum of sharp edges on the surface of attack.

The problem of the pastilles with vitreous binder is the size of the grains. Their great specific surface requires an increase in the liquid phase during cooking so that all the grains are coated by vitreous film. The surface density of the corundum grains on the active face of the pastille is thus reduced, which reduces the rate of removal on ground glass. As for the pastille itself, its density connects is increased, which leads to its slip on the surface of glass.

To finish, let us note that the flexible matrix of the corundum grains must be softened to confer to the tool certain elasticity. For that, it is used binders with soft metal alloy, resinoides or organics.

REFERENCES

Kingery, W.D., E. Niki and M.D. Narasimhan, 1961. Sintering of oxide and carbide- metal compositions in presence of a liquid phase. J. Am. Ceram. Soc., 44: 29-35.

Konig, W. and N. Koch, 1989. Grinding of optical glasses with cup wheels Glastech. Ber., 62: 358.

Mansouri, S., K. Loucif, D. Bouzid and N. Bouaouadja, 2006. Effect of the content while binding on effectiveness of grinding of the optical components by alumina agglomerates tools.-analogies with the alloys Cu-Sn. PHOTOCAT., pp: 98.

Parks, R.E. and C.J. Evans, 1994. Rapid post-polishing of diamond turned optics Precision Eng., 16: 223-227.

Raffino, P., 1978. Granulométrie and Technique de l'ingénieur, 6: 555.