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(54) Title: **ENCAPSULATED MATERIAL**

(57) **Abstract:** The present invention relates to the use of encapsulated superabrasive (diamond or cBN) grit in having a particle size of (greater than) >500 um any one or more of the following application areas: drills, saw blades, band saw blades, hacksaws, frame saws, concrete polishing, ore drill bits, wire beads, impregnated bits, roller cone bits, twist drills, wear parts, grinding wheels, grinding tips, rotary dressers, dresser logs for single and multiple log dressers, profile dressers, straight and profiled routers, polishing cups, single point tools, calibration rollers, wire drawing dies, single point turning tools, gauge materials, and hard facing. The invention further relates to an encapsulated superhard particle including: a superhard particle having a particle size of (greater than) >500 um; optionally, a coating applied to the superhard particle; and a layer of encapsulation material wherein the encapsulated superhard particle includes a plurality of encapsulation layers and/or the encapsulation layer(s) include(s) a discrete or continuous gradient.



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ENCAPSULATED MATERIAL

INTRODUCTION

This invention relates to encapsulated superhard material. In particular, this invention relates to an encapsulated superhard particulate material which is either uncoated or coated.

This invention further relates to the use of encapsulated superabrasive grains (diamond and cBN) in a wide range of applications area. This invention further relates to using encapsulated grit in the manufacture of tools, inserts for tools, or any components of an abrasive tool by sintering technologies such as hot pressing, hot isostatic pressing (Hipping), high temperature high pressure (HTHP), free sintering, infiltration sintering, electro discharge sintering (EDS), field assisted sintering technology (FAST) plasma spark and laser sintering.

BACKGROUND TO THE INVENTION

GB1014295 (Norton, 1965) describes encapsulated abrasive articles produced by an inclined pan method. The pellets produced can be placed in a mould cavity, cold pressed and sintered, or alternatively finished shapes may be formed by hot pressing. It is stated that the encapsulated articles provide a uniform distribution of diamond in core drill, diamond bits and diamond wheels. The metal powders used have sizes from 1 to 12 microns and may be cobalt, mixtures of tungsten carbide and cobalt, steel mixtures and copper and tin mixtures. In order to produce good distribution of the diamond in the abrasive tool, a mixture of pellets and diamond of more than one size can be used. The pellets are formed so that the volume of the bonding medium in each pellet is at least nine times the volume of the central diamond. The patent only describes in how it can improve the manufacture and performance of sintered wheels

EP0012631 (Tomlinson, DeBeers, 1983) describes the product and process of a pellet which consists of an initial coating of Ti (0.5 μm thick) which is encapsulated with a hard metal powder mixture by the pan rotating method. The pellet is then heat treated in order to form a sintered abrasion resistant layer where the Ti coating forms a strong bond with the core and the outer layer. The outer abrasion resistance layer enables the pellet to be used more readily as an article of commerce than if it were used in the unsintered green state. The patent also describes the use of these sintered pellets for making diamond impregnated cutting inserts for coring bits and incorporating the pellets in a standard metal matrix for making circular saw segments.

US4770907 (Kimura, Fuji Paudal, 1988) claims a method for producing pellets by the fluidized bed route. The patent claims using such pellets produced by the fluidized bed in a press moulding operation for manufacturing metal bonded diamond tools. In the description of the fluidized bed route there is described a rotatable perforated plate disposed immediately beneath the work area of the fluidized bed granulating apparatus which can be rotated throughout the course

of the granulating operation to complimentary circulate the abrasive grain cores within the material work area during fluidization (by a fluidizing air flow) of the cores. The method of granulating may be performed with granulating apparatuses having either a fixed or rotatable perforated plate.

US5143523 (Matarrese, GE, 1992) follows the basic coating process and machinery disclosed in US4770907 (Kimura, Fuji Paudal, 1988) but describes a number of variations. US5143523 (Matarrese, GE, 1992) claims the method of producing metal clad particle pellets by coating the abrasive particles with a carbide forming metal and then encapsulating using a fluidization method, and heat treating first of all to form a sintered outer metal coating and then at a higher temperature to liquefy the carbide forming metal for forming some metal carbide from the diamond. The patent also claims using the above particles in combination with metal pellets devoid of abrasive grains and a source of braze material in a mold cavity under conditions of temperature, pressure and atmosphere to form an abrasive particle containing metal saw blade segment of desired abrasive particle concentration. The only application described in the patent for using the abrasive pellet is in saw blade cutting segments.

US5405573 (Clark et al., GE, 1995) is somewhat similar to US5143523 (Matarrese, GE, 1992). However, US5405573 (Clark et al., GE, 1995) describes only applying one encapsulated coating by the fluidization process with the green pellets produced undergoing one sintering step. In addition, the inventors claim metal saw blade segments which contain a semi-ordered array (an array of at least two rows parallel with the lengthwise extent of a segment) of spaced apart abrasive pellets.

US6238280 (Ritt et al., Hilti, 2001) discloses an abrasive cutters which contain a diamond particle with a particle size of about 50 μm to 500 μm which is surrounded with a 10 μm to 200 μm coating. The coating which is applied by fluidised bed has a layered construction of different compositions. The coating

can either have individual layers of different compositions where the compositional changes are sudden, or the coating can have a continuous compositional gradient change. The individual encapsulated diamond pellets can be used either unsintered or sintered. In addition, the pellets may be further processed to produce porous composite cutters with a particle size of about 400um to 14000um by build up granulation. Methods that are listed for build up granulation include mask granulation, screen granulation or the addition of several cutters in a fluidised bed process. The applications described for the individual cutters or composite cutters can be used in are hollow drill crowns, wall saws, cutting off wheels and grinding disks.

US6102140 (Boyce et al., Dresser, 2000) describes an insert for a ground engaging tool, with a plurality of sockets for receiving a respective insert comprises a body having first and second portions and first and second zones. The first zone may consist of tungsten carbide and metallic cobalt, with pre-selected dimensions adapted for press fitting within a respective socket of the ground engaging tool. The second body portion may define an earth engaging portion. The second zone may consist of encrusted diamond pellets, tungsten carbide and metallic cobalt, fused together. The first and second zones may be fused together with the first zone being substantially free of encrusted diamond pellets.

In a similar manner US6170583 (Boyce et al., Dresser, 2001) describes an insert for a rock bit for drilling bore holes in the ground and other downhole tools. The cutting portion of the inserts consist of encrusted cubic boron nitride pellets, tungsten carbide particles and a binder material which are fused together to form a unitary body. The cubic boron nitride particles of the fused insert are cubic in structure and substantially free of heat degradation and resultant hexagonal crystalline structure in response to fusing the elements together in a single step of simultaneously heating and compacting the elements.

US5755298, US5755299, US6138779 & US6469278 describe using encapsulated diamond, cBN or other abrasives for hardfacing to protect the wear surfaces of drill bits and other downhole tools. Generally the coating (in this case an encapsulated layer) on the ceramic particle or particles of other hard materials may be formed from materials and alloys such as tungsten carbide, and tungsten carbide/cobalt and cermets such as metal carbides and metal nitrides. The coated particles are preferably sintered and have a generally spherical shape. The coated particles are pre-mixed with selected materials such that welding and cooling will form both metallurgical bonds and mechanical bonds within the solidified matrix deposit. A welding rod may be prepared by placing a mixture of selected hard particles such as coated cubic boron nitride particles, hard particles such as tungsten carbide/cobalt, and loose filler material into a steel tube. A substrate may be hardfaced by progressively melting the welding rod onto a selected surface of the substrate and allowing the melted material to solidify and form the desired hardfacing with coated cubic boron nitride particles dispersed within the matrix deposit on the substrate surface.

US2006/0081402 (Smith, Lockwood et al., 2006) describes an insert for a drill bit that includes diamond particles disposed in a matrix material, wherein the diamond particles have a contiguity of 15% or less is disclosed. A method of forming a diamond-impregnated cutting structure, that includes loading a plurality of substantially uniformly coated diamond particles into a mold cavity, pre-compacting the substantially uniformly coated diamond particles using a cold-press cycle, and heating the compacted, substantially uniformly coated diamond particles with a matrix material to form the diamond impregnated cutting structure is also disclosed. The contiguity of 15% is achieved by encapsulating the particles. The particles may also be coated, for example with TiC, prior to encapsulation. Although reference is made to a hot pressing process or a high temperature, high pressure press (HTHP) process, a combination of the aforementioned may also be used. Alternatively another suitable method for hot compacting pre-pressed diamond / metal powder mixtures is hot isostatic

pressing. Further, bi-modal or multi-modal mixtures of pellets may be chosen to increase diamond density.

The review of the prior art suggests that encapsulated grit has so far being restricted to the following applications:

- Core drill, diamond bits and diamond wheels. GB1014295 (Norton, 1965)
- Circular saw segments & cutting inserts for coring bits. EP0012631 (Tomlinson, DeBeers, 1983)
- Saw blade cutting segments. US5143523 (Matarrese, GE, 1992) US5405573 (Clark et al., GE, 1995)
- Inserts containing encapsulated diamond grit for a drill bit. US2006/0081402 (Smith, Lockwood et al., 2006). US6102140 (Boyce et al., Dresser, 2000) & US6170583 (Boyce et al., Dresser, 2001)
- Hollow drill crowns, wall saws, cutting off wheels and grinding disks. US6238280 (Ritt et al., Hilti, 2001)
- Hardfacing to protect the wear surfaces of drill bits and other downhole tools. US5755298, US5755299, US6138779 & US6469278

However, there are numerous other application areas, particularly in the oil and gas industry, that require improvement in tool performance

In addition, for certain applications, there are limitations to the prior art methods by which tools using encapsulated grit can be produced. In particular, the use of hot pressing is limited to very basic geometrical shapes, most typically cylinders. Therefore, improved methods to produce sintered segments are required.

US5143523 (Matarrese, GE, 1992) and US5405573 (Clark et al., GE, 1995) describe encapsulating abrasive particles. However, the authors only describe a method for applying a single or dual type of encapsulated layer. No reference is made to either having more than two layers (i.e. multilayered) or having a compositional gradient over 1 or more layers.

US6238280 (Ritt et al., Hilti, 2001) describe the use of multilayered encapsulated grit with and without gradual compositional gradients which can then be used in various applications. This disclosure is limited in that the bond material encapsulates straight onto bare diamond. The potential issues with this are:

- (1) The encapsulating bond material may react with the surface of the diamond, thereby causing a strength reduction and loss in shape, which ultimately affects performance in application.
- (2) The bonding between the encapsulating bonding material and the substrate may be poor and any bonding that does occur is dependent on controlled sintering of the green pellet.

In addition, US6238280 (Ritt et al., Hilti, 2001) describes that the main applications for this product are in are hollow drill crowns, wall saws, cutting off wheels and grinding disks. The resulting grit size that is described and claimed only covers (final) particle sizes of from 50 μm to 500 μm . The authors do not describe such multilayered encapsulated grit on sizes smaller than 50 μm or larger than 500 μm .

A need exists for encapsulated abrasive material having dimensions greater than 500 μm . From a method perspective, there is a need to have a technique which can produce the aforementioned encapsulated material (pellets) which have a superhard, preferably diamond, particle size of (greater than) >500 μm . In addition, it would be useful if this technique was applicable to fluidised bed techniques so that pellets which have a diamond particle size <500 μm can also be produced. In addition, on grit sizes less than <500 μm , the wall thickness of the multilayered coatings described in US6238280 (Ritt et al., Hilti, 2001) is currently limited to 10-200 μm when produced by the fluidised bed route. A need therefore exists for a technique which allows for greater coating thicknesses to be achieved which, in turn, results in an improvement in performance.

SUMMARY OF THE INVENTION

According to a first aspect to the present invention there is provided use of encapsulated superabrasive grit in having a particle size of (greater than) >500 um any one or more of the following application areas:

- Drills,
- Saw blades
- Band saw blades,
- Hacksaws,
- Frame saws,
- Concrete polishing,
- Core drill bits,
- Wire beads,
- Impregnated bits,
- Roller cone bits,
- Twist drills,
- Wear parts,
- Grinding wheels,
- Grinding tips,
- Rotary dressers,
- Dresser logs for single and multiple log dressers,
- Profile dressers,
- Straight and profiled routers,
- Polishing cups,
- Single point tools,
- Calibration rollers,
- Wire drawing dies,
- Single point turning tools,
- Gauge materials, and
- Hard facing.

In this description, the terms superhard and superabrasive are used interchangeably.

The particle size is measured against the largest dimension/diameter of the particle. As such, it will be appreciated that once the particle is coated/encapsulated, the dimensions of the pellet will be even greater.

The encapsulated superabrasive grit may be used throughout the entire tool, in certain designated areas on the tool or as an insert or as an add-on component for the tool.

The encapsulated superabrasive grit may be uncoated or coated with a thin (<10 μm) coating prior to encapsulation. The coating may be a single layer or multilayer coating and may be chemically and/or physically bonded to the surface of the grit. Examples of coatings include chemically bonded carbide, borides nitrides or any mixture thereof. Specific examples include TiC and CrC. Examples of physically bonded coatings include W and Ag. The coatings may be applied by any technique known in the art such as chemical vapour deposition (CVD), physical vapour deposition (PVD), plating or other equivalent hot or cold processes.

The encapsulation layer may consist of single or multilayered, sintered or unsintered, bond powder. The bond powder may be metallic, ceramic, cermet or any mixture thereof. Examples of typical bond powder include Cu, Fe, Ni and Co.

The encapsulation may be performed by fluidised bed route, pan rotating, shovel rotor or any combination thereof.

Segments, tools, inserts or any component containing the above encapsulated grit may be produced by the following sintering techniques which have the advantages as set out below:

- Hot pressing,
 - High densification, high quality product, small batch process, near net sizing.
- Hot isostatic pressing (HIPPING),
 - Very high densification, large batch sizes.
- High Temperature / High Pressure (HTHP),
 - Prevents diamond graphitisation.
- Free sintering,
 - Relatively inexpensive, large batch sizes.
- FAST
 - Quick sintering, can sinter difficult to sinter materials.
- Electro Discharge Sintering
 - Quick sintering, can sinter difficult to sinter materials, can sinter and attach working portion to body in one step.

In the above applications, the purpose of the encapsulated grit is to provide control over the tool design parameters as described below:

- Even distribution of abrasive,
- Regular arrays of abrasive,
- Abrasive properties can be varied in terms of:
 - Size, strength, shape, concentration and coating of abrasive particle(s),
 - size, composition and shape of the encapsulated pellet.

Control over these parameters allows for improved performance in application. For oil and gas applications, the increase in performance will typically be seen in the following outputs:

- Improved rate of penetration (ROP),
- Reduced wear,
- Longer tool life,
- More economic cutting, and
- Steadier power consumption (i.e. less tool vibrations).

According to a second aspect to the present invention, there is provided an encapsulated superhard particle including:

- a superhard particle having a particle size of (greater than) >500 μm ;
- optionally, a coating applied to the superhard particle; and
- a layer of encapsulation material

wherein the encapsulated superhard particle includes a plurality of encapsulation layers and/or the encapsulation layer(s) include(s) a discrete or continuous gradient. As above, it is also envisaged that the layer of encapsulation material may also be applied directly to an uncoated superhard particle.

Preferably the superhard material is selected from diamond, cubic boron nitride, a carbide, oxide or silicide, TiC , Si_3N_4 , SiC , Al_2O_3 , AlC and/or SiO_2 . Most preferably the superhard material is diamond. The diamond may be natural or synthetic. Synthetic diamond may be synthesized by chemical vapour deposition or High Pressure High Temperature (HPHT) techniques.

Definitions:

Encapsulated Particles

Encapsulated particles, such as abrasive grit, are particles that have been encapsulated within an envelope comprising a mass of particulate materials, such as metal, metal alloy, ceramic and/or cermet powders or combinations thereof, by any process involving the use of a distinct binder to hold the particulate material together. Typically the binder is an organic material. The binder may be subsequently removed and the particulate material can be partially or fully sintered.

Coated / Clad Particles

Coated particles can be described as having a core comprising at least one said particle which is fully or partially surrounded by a layer or layers of material either physically or chemically bonded to the surface of the particle. In this invention the

coating differs to encapsulation in that the process for producing the coating does not rely on a binder material holding particulate material together immediately after deposition. The coating may either completely or partially cover the surface of the core particle(s). Processes for producing coatings include: chemical vapour deposition (CVD), physical vapour deposition (PVD), other equivalent hot or cold processes, plating, sol-gel or ceramic coatings produced using polymer pre-cursors. The coating thickness can be anything ranging from a mono-atomic layer up to hundreds of micron, but typically range from 0.1 μm to 5 μm . In instances where the coating thickness is large relative to the size of the abrasive particle (e.g. where the thickness of the coating is greater than about 5% the diameter of the core particle), then the coating can be further classified as a cladding. In the case of a cladding the preferred methods for deposition include electroless and electrolytic deposition.

In order to prevent components in the encapsulation layer damaging the surface of the diamond, a coating is preferably used on the diamond. Such coatings preferably include but are not limited to elements from group II to IV of the periodic table of the elements, most preferably Ti and W, alloys thereof, coatings based on carbides, nitrides and/or oxides of the aforementioned elements or any combination of the above. Specifically, thin (<10 μm) Ti and Cr based carbide coatings applied by chemical vapour deposition (CVD), physical vapour deposition (PVD) or other equivalent hot or cold processes are particularly useful.

The thickness of the coating is preferably not greater than 10 μm . The thickness of the coating is preferably at least 0.1 μm thick and most preferably at least 0.4 μm thick.

It has been shown that the coatings provide protection to the surface of diamond particles when sintering in aggressive bond materials. In addition, when the appropriate coating is selected, the coating can undergo a chemical/metallurgical reaction with the encapsulation layer during sintering. Thus, the coating results

in improved retention of the grit in the encapsulated material (pellet) by creating a strong chemical bond between the diamond and the coating and encapsulation layer and the coating. Increased retention will result in improved performance of any tool in which such encapsulated material is included, such as tool life or cutting, grinding and drilling rate. Furthermore, it has been found that the presence of a coating, as compared to uncoated diamond, facilitates better wetting of the bond powder to the abrasive during the initial stages of encapsulation.

To meet the demand from the oil and gas industry to have tailor made designs in order to suit a toolmaker's particular bond and manufacturing system requirements, and ultimately to improve the performance of the tool, the solution to the abovementioned problem lies in supplying multilayered encapsulated grit according to the present invention that has a particle size > (greater than) 500 μm . As such, the present invention is capable of delivering 'signature' encapsulated material in the sense that the material can be constructed bespoke to the needs of the industry.

The encapsulation layer may be comprised of sintered or unsintered bond powder. The bond powder may be metallic, ceramic, cermet or any mixture thereof. Examples of typical bond powder include Cu, Fe, Ni and Co. Another example includes coarse or fine grained WC powder.

The thickness of the encapsulation layer is preferably not greater than three times the size (largest dimension/diameter) of the starting abrasive grain. The thickness of the encapsulation layer is preferably at least 10% the size of the largest dimension/diameter of the starting abrasive grain.

In a preferred embodiment of the present invention signature multilayered encapsulated grit consists of;

- a superhard particle having a particle size of (greater than) >500 μm ; and

- at least two discrete encapsulation layers;
wherein the composition of the encapsulation layer(s) gradually and/or intermittently changing throughout thickness of the encapsulation coating, either continuously or discretely. The grit may be uncoated or coated.

There are a number of methods which could be potentially used to produce signature multilayered encapsulated grit according to the present invention. These include pan rotating and/or fluidised bed methods. Both of these methods have a number of disadvantages which can be overcome by the use of a shovel rotor method as described in co-pending application claiming priority from ZA2007/06077, the contents of which are incorporated herein by reference.

Applicant's co-pending applications claiming priority from ZA2007/06075 and/or ZA2007/06076 are included herein by reference.

The invention will now be described with reference to the following non-limiting examples.

Example 1 TiC coated grit with an inner encapsulated hard bond and outer encapsulated softer bond.

20,000 cts of element six SDB1100 25/35 US mesh grit was coated with a 0.6 μ m chemically bonded TiC coating using a CVD process. The coated material was then placed into a shovel rotor and encapsulated using slurry which consisted of Umicore's Cobalite HDR bond powder, polymer binder and a solvent. The shovel rotor was activated and the material was left in the shovel rotor until the pellet (i.e. diamond grit, coating and encapsulated layer) was built up to an average diameter of 1 mm. At this stage the slurry mixture was changed to that consisting of Umicore's Cobalite CNF powder instead of Cobalite HDR. The shovel rotor was then activated and the pellet was built up until the average

diameter reached 1.2 mm. A handleable pellet of greater than 500um consisting of a diamond grain coated with TiC and encapsulated with two distinct layers of bond material was thus produced.

Example 2: TiC coated grit with encapsulated layers consisting of Fe bond material with changing particle size.

1,000 cts (200 g) of element six SDB1100 25/35 US mesh grit was coated with a 0.6 um chemically bonded TiC coating using a CVD process. The coated grit was then placed inside a fluidised bed chamber. Slurry which consisted of 1-50 um Fe bond powder, polymer binder and a solvent was prepared. The fluidised bed was activated and the slurry was added in a controlled manner until 200 g of Fe was built up on the original charge of 1,000 cts.

At this stage new slurry was prepared which consisted of 50-75 um Fe powder, polymer binder and solvent. The fluidised bed was activated and the slurry was added in a controlled manner until a further 200 g of Fe was built up on the charge, giving a total weight of Fe of 400 g.

The material was transferred to a rotating pan where a further 3,600 g of 50-100 um Fe powder was built up on the charge. In this instance the Fe powder was added separately to the polymer binder and solvent.

A handleable pellet consisting of a diamond grain coated with TiC and encapsulated with three distinct layers of Fe bond material was thus produced.

Example 3: Uncoated grit with inner encapsulated layer of Co with WC (P1) hard phase and outer layer of softer Co.

1,000 cts (200 g) of element six SDB1100 25/35 US mesh grit was placed inside a fluidised bed chamber. Slurry which consisted of P1 bond, polymer binder and a solvent was prepared. The fluidised bed was activated and the slurry was added in a controlled manner until 400 g of P1 was built up on the original charge of 1,000 cts.

The material was transferred to a rotating pan where a further 800g of P1 powder was built up on the charge. In this instance the P1 powder was added separately to the polymer binder and solvent.

At this stage, the powder being added was changed from P1 to Co powder, and 750g of Co was built up. A handleable pellet consisting of a diamond grain encapsulated with an inner high abrasion resistant layer of P1 (i.e. Co with tungsten carbide hard particles) and an outer lower abrasion resistant layer of Co only was produced.

Example 4: TiC coated grit with inner encapsulated layer of P1 hard phase and outer layer of softer P2.

20,000 cts (4000 g) of element six TiC coated SDB1100 25/35 US mesh grit was placed inside the shovel rotor chamber. Slurry which consisted of Powder 1 bond, polymer binder and a solvent was prepared. Powder 1 (P1) comprises WC:Co in the ratio 1:1. The shovel rotor was activated and the slurry was added in a controlled manner until 20,000 g of P1 was built up on the original charge of 20,000 cts.

At this stage, the powder being added was changed from P1 to Powder2 (P2) which consists of WC:Co in the ratio of 3:7, where a further 20,000 g of P2 was built up. A handleable pellet consisting of a TiC coated diamond grain encapsulated with an inner high abrasion resistant layer of P1 (i.e. Co with

tungsten carbide hard particles) and an outer lower abrasion resistant layer of P2 only was produced.

Example 5: TiC/W coated grit encapsulated with 5 discrete layers of varying composition.

5 slurries which consisted of bond powder, binder and solvent were prepared. The slurries differed in that the composition of the bond powder was as per Table 1 below.

20,000 cts of element six TiC and W coated SDB1100 25/35 US mesh grit was placed inside the shovel rotor chamber. The shovel rotor was activated and Slurry No. 1 was added in a controlled manner until the slurry was exhausted. Slurries No. 2 to 5 was then added sequentially, in the same manner as described above. A handleable pellet consisting of a coated diamond grain encapsulated with 5 discrete layers of varying composition was thus produced.

Table 1: Wt of Cobalite HDR & Cobalite CNF bond powder in slurry

Slurry No.	1	2	3	4	5
Wt of HDR in slurry (g)	8	6	4	2	0
Wt of CNF in slurry (g)	0	2	4	6	8

Example 6: TiC coated grit encapsulated with a layer consisting of a continuous compositional gradient.

20,000 cts of element six SDB1100 25/35 US mesh grit was coated with a 0.6 μ m chemically bonded TiC coating using a CVD process. The coated material was then placed into a shovel rotor and encapsulated using slurry which consisted of Umicore's Cobalite HDR, binder and organic solvent. The shovel

rotor was activated and the material was left in the shovel rotor until 10,000 g of Cobalite HDR was built up on the original charge of 20,000 cts.

Following from the above, two batches of slurry were prepared. One batch contained 10,000 g of Cobalite HDR and the other batch contained 10,000 g of Cobalite CNF. The shovel rotor was activated and the slurry consisting of Cobalite CNF, polymer binder and solvent was added to the HDR slurry at the same rate in which the slurry containing HDR was being sprayed into the shovel rotor chamber. In this manner a continuous compositional gradient from Cobalite HDR to Cobalite CNF was achieved.

Following from the above, a further 10,000 g of CNF was built up on the charge.

Example 7: Binder burnout and pre-sintering of examples 1 - 6.

In order for the materials described in the above examples to be used in different applications, the polymer binders were firstly removed by heat treating the pellets from 250°C to 500°C in an inert atmosphere. Secondly, the pellets were further heat treated at temperatures ranging from 650°C to 950°C in an inert atmosphere in order to pre-sinter the pellets.

Example 8: Material from example 4 used in an impregnated post for the oil and gas industry.

This example serves to illustrate how any of the above material from examples 1 to 5 can be used to manufacture an impregnated post.

Graphite moulds were prepared with a 20 mm diameter chamber. Two plungers were machined from graphite which fitted neatly into the 20 mm diameter

chamber. One of the plungers was placed in the bottom of the mould. 60 g of encapsulated material from example 4 was poured into the mould and the top plunger was pressed down on the material. The assembly consisting of the graphite mould, plungers and encapsulated material were then transferred to a hot pressing machine. The assembly was hot pressed for 5 minutes at between 1,000-1,300°C. Upon cooling the assembly was removed from the machine. The plungers were removed and the sintered post was removed. The sintered post thus produced can be used as an insert for downhole tools.

CLAIMS

1. Use of encapsulated superabrasive grit in having a particle size of (greater than) >500 um any one or more of the following application areas:

- Drills,
- Saw blades
- Band saw blades,
- Hacksaws,
- Frame saws,
- Concrete polishing,
- Core drill bits,
- Wire beads,
- Impregnated bits,
- Roller cone bits,
- Twist drills,
- Wear parts,
- Grinding wheels,
- Grinding tips,
- Rotary dressers,
- Dresser logs for single and multiple log dressers,
- Profile dressers,
- Straight and profiled routers,
- Polishing cups,
- Single point tools,
- Calibration rollers,
- Wire drawing dies,
- Single point turning tools,
- Gauge materials, and
- Hard facing.

2. Use according to claim 1 wherein the encapsulated superabrasive grit is used throughout the entire tool, in certain designated areas on the tool or as an insert or as an add-on component for the tool.
3. Use according to claim 1 or 2 wherein the encapsulated superabrasive grit is coated with a coating prior to encapsulation.
4. Use according to any preceding claim wherein the encapsulation layer consists of single or multilayered, sintered or unsintered, bond powder.
5. Use according to any preceding claim wherein the bond powder is metallic, ceramic, cermet or any mixture thereof.
6. An encapsulated superhard particle including:
 - a superhard particle having a particle size of (greater than) >500 μm ;
 - optionally, a coating applied to the superhard particle; and
 - a layer of encapsulation materialwherein the encapsulated superhard particle includes a plurality of encapsulation layers and/or the encapsulation layer(s) include(s) a discrete or continuous gradient.
7. A particle according to claim 6 wherein the superhard material is selected from diamond, cubic boron nitride, a carbide, oxide or silicide, TiC , Si_3N_4 , SiC , Al_2O_3 , AlC and/or SiO_2 .
8. A particle according to claim 6 or 7 wherein the encapsulated superhard particle is coated with a coating prior to encapsulation.
9. A particle according to claim 8 wherein the thickness of the coating is not greater than 10 μm .

10. A particle according to claim 8 or 9 wherein the thickness of the coating is at least 0.1 μm thick.
11. A particle according to any preceding claim wherein the encapsulation layer is comprised of sintered or unsintered bond powder.
12. A particle according to any preceding claim wherein the thickness of the encapsulation layer is not greater than three times the size (largest dimension/diameter) of the starting abrasive particle.
13. A particle according to any preceding claim wherein the composition of the encapsulation layer(s) gradually and/or intermittently changes throughout the thickness of the encapsulation coating, either continuously or discretely.