Title: PROCESS FOR PREPARING PLATELET-LIKE (EMBOSSED) PARTICLES

Abstract: The present invention relates to a process for preparing platelet-like particles and to embossed particles.
Process for Preparing platelet-like (embossed) Particles

The present invention relates to a process for preparing platelet-like particles and to embossed particles.

US4,321,087 discloses a continuous process for preparing finely divided thin, bright metal particles which comprises applying a release coating to at least one side of a carrier sheet, depositing a metal film of from 350 to 450 angstroms thickness onto the release coating solubilizing the release coating, removing the metal film from the carrier sheet, and breaking the thin metal film into particles having a diameter of between 25 to 50 microns. The process of US4,321,087 produces very thin, bright metallic flakes with extremely smooth (mirror-like) surfaces. The flakes serve as excellent pigments and, when properly employed can offer metal-like or mirror-like optical effects.

In a parallel development, diffraction patterns and embossments, and the related field of holographs, have begun to find wide-ranging practical applications due to their aesthetic and utilitarian visual effects.

Iridescent coatings and effects have been known for several thousand years, however, the first mass produced iridescent patterns were formed by Ramsden Wood in 1946. A ruling engine mechanically engraved equidistant lines one seven hundredths of an inch apart over an area of 1 inch or 25 millimetres. Portions of this iridescent pattern were segmentised and transferred to a metal plate in the form of diamonds, squares and various other patterns over a 6 inch by 6 inch plate. These plates were used to produce electroformed nickel shims or embossing tools. The shims were mounted onto a polished steel cylinder which was heated to around 250 degrees F and a vacuum metallised film of PET was pressed against the relief structures on the surface of the shim under high pressure using an additional polished steel roller. This process of pressing the heated shim surface into the aluminium deposited metal on the carrier substrate transferred the iridescent image into the film carrying the metal coating. The result was a roll of an iridescent pattern film which could be subsequently printed and dies cut to produce labels and stickers. However, despite such widespread use.

The use of holographic and straight line diffraction gratings is fairly expensive and generally involves the preparation of hot or cold stamping foils, transfer foils and in a separate operation adhering or laminating such holographic or straight line diffraction effects to the intended article such as a credit card, cheques, stock certificates or verification/identification card.
US4,913,858 shows one prior art method of embossing holographic images or diffraction pattern to a plastic film or to a plastic coating of a substrate, such as a paper sheeting.

EP0643745B1 (US5,624,076) relates to a process for preparing finely divided metal particles, each of which has at least one embossed surface, comprising the steps of providing a carrier sheet having a first side and a second side; and depositing a metal in the form of a thin film onto said carrier sheet, passing said carrier sheet through a release enviroment, which causes the film to separate from the carrier sheet, but which is non-destructive of said metal; removing said film of said metal from said carrier sheet in a particulate form to produce metal particles, collecting the metal particles in a solvent which is non-reactive with said metal; and breaking the metal particles into pigment particles; characterized in that one side of the carrier has an embossed surface comprising a diffraction grating, in which the metal film is applied to said embossed surface to adopt the complement of the diffraction grating, in which said pigment particles retain surface embossments transferred from the diffraction grating to said film; and to a product comprising finely divided embossed metal particles formed by the above process. According to EP0643745B1 the term diffraction grating includes holographic images that are based on diffraction grating technology, wherein it is said that the original diffraction gratings were formed by scribing closely and uniformly spaced lines on polished metal surfaces using special "ruling engines".

US6,112,388 discloses a method for producing embossed metallic flakelets, comprising a step of forming an embossed pattern on an organic-inorganic composite layer; a step of forming a metallic film on the embossed pattern; a step of forming an organic-inorganic composite layer on the metallic film; and a step of forming flakelets from the metallic film.

US6,168,100 discloses a method of producing embossed metallic flakelets, comprising: pressing a metallic foil on its opposite surfaces between a cooperating pair of dies, which have two mutually complementary embossed patterns, to form on the surfaces of the metallic foil undulation corresponding to the embossed pattern of the dies; and pulverizing the metallic foil into metallic flakelets.

US6,692,830 relates to a diffractive pigment flake, comprising: a layer of a first material having a reflective surface; and a diffractive structure formed on the reflective surface, the diffractive structure having a pitch and amplitude selected to decrease the intensity of a zero order diffracted light beam in order
to increase the intensity and color contrast of at least one higher order diffracted light beam. The grating structure utilized according to US6,692,830 has a diffraction grating pattern with a frequency of from about 1000 to about 4000 grating In/mm, preferably from about 1400 to about 3500 grating In/mm, and more preferably from about 1400 to about 2000 grating In/mm. The gratings can have a groove depth of about 20 nm to about 300 nm, and preferably from about 100 nm to about 250 nm.

US5,912,7671 describes diffractive indicia for a surface, comprising:
(a) a plurality of small separate diffractive elements, and
(b) means for adhering the diffractive elements to the surface, wherein: each diffractive element has, before being applied to the surface a diffractive surface relief structure; the diffractive elements, when applied to the surface, are not separately resolvable to the human eye; and the appearance of the diffractive indicia, when applied to the surface, changes when the viewing angle and/or angle of illumination relative to the surface changes. Diffracting surface structure may consist of grooves, pits, geometrically shaped indentations, or any combination of these. However, a straight line grating diffracts only in particular directions relative to the angle of illumination, whereas it is preferred for the purposes of the present invention that the diffractive effect be observable from any direction, so it is preferred that the diffracting structure be such as to cause diffraction in numerous different directions at the same time, and it is especially preferred that the diffracting structure comprise substantially concentric circular grooves. Other suitable structures include polygonal indentations arranged in substantially concentric circular patterns, and substantially concentric regular polygonal grooves.

Other patents which disclose various methods for forming holograms or diffraction grating images on substrates include US4,773,718, 4,728,377, and 5,087,510.

It is the general object of the present invention to provide a process for making very thin, bright (embossed) (metallic) flake pigments (platelet-like particles) rapidly and inexpensively.

Further objects of the present invention are to introduce an iridescent effect that is not a straight line diffraction grating or hologram and to alter the sequence of process steps, taking out the release layer which is embossed and metallised, following the particularising of the metal the carrier film is re-coated and re-embossed and metallised.
Said objects are solved by the embossed particles of claim 5 and the process for preparing (embossed) particles of claim 1.

When the (diffractive) flakes consist of a single layer, a reflective material can be used to form said layer. Presently preferred reflective materials include various metals or metal alloys because of their high reflectivity and ease of use, although non-metallic reflective materials can also be used.

The (embossed) platelet-like particle is preferably a metal particle. The metal pigment particles may comprise any suitable metal. Nonlimiting examples of suitable metallic materials include aluminum, silver, copper, gold, platinum, tin, titanium, palladium, nickel, cobalt, rhodium, niobium, stainless steel, nichrome, chromium, and compounds, combinations or alloys thereof. The particles may comprise any one or more selected from the group comprising aluminium, gold, silver, platinum and copper. Preferably, the platelet-like particles are aluminium, silver and/or copper flakes.

The (embossed) platelet-like particle can be an optical stack, or an optically variable multi layer thin film interference stack.

The diffractive flakes can have a three layer design with a generally symmetrical thin film structure, including a central reflector layer and opposing dielectric layers and on opposing major surfaces of reflector layer but not on at least one side surface of the reflector layer. The reflector layer can be composed of the same reflective materials as discussed previously for the single layer flakes. The dielectric layers can be composed of various dielectric materials such as those having a refractive index of about 1.65 or less, and preferably a refractive index of about 1.5 or less. Nonlimiting examples of suitable dielectric materials include magnesium fluoride, SiO₂ (1 ≤ z < 2, especially 1.4 ≤ z < 2), silicon dioxide, aluminum oxide, aluminum fluoride, cerium fluoride, lanthanum fluoride, neodymium fluoride, samarium fluoride, barium fluoride, calcium fluoride, lithium fluoride, and combinations thereof. The reflector layer can have a physical thickness of from about 40 nm to about 200 nm, and preferably from about 80 nm to about 160 nm. The dielectric layers can each have a physical thickness of about 1 micron or less, preferably from about 200 nm to about 600 nm, and more preferably from about 250 nm to about 450 nm.

In one preferred embodiment of the diffractive flakes, a transparent dielectric material, such as magnesium fluoride (MgF₂), or SiO₂, can be deposited as a first layer and third layer to
form stiffening protective layers over a second (inner) opaque aluminum layer. The MgF$_2$, or SiO$_2$ layers are preferably each about 250 nm to about 450 nm thick, and the aluminum layer is preferably about 80 nm to about 160 nm thick. The diffractive flakes have a total thickness of less than about 1,400 nm, and preferably from about 500 nm to about 900 nm.

The embossed particle of the present invention has preferably an optically knitted micro structure having infinite areas of iridescent surface.

A composite sheet having an iridescent effect and a method of forming an iridescent compound permits producing a final product to coat the iridescent effect directly on a substrate. The composite sheet includes successively, a plastic carrier film, an embossment and a layer of metal. The former of which becomes embossed with areas of woven, or optically knitted microprofiles which diffract light. When the composite sheet is passed through a release situation which causes the metal layer to be removed in particulate form iridescent metal particles are produced. The particles are collected in a non-reactive solvent. The iridescent particles are broken into pigment particles having an average diameter between 10 to 50 microns and a thickness of 10 to 50 nm.

The present invention provides a more efficient less expensive method for creating the (metal) fakes and subsequent commercial product and applications. Products include but are not limited to decorative iridescent spray paints for automotives, motor cycles, bicycles, coatings for telephone receivers, computer monitors, CPU’s, printers and photocopiers. Decorative coatings for display, exhibition TV and film sets, inks and compounds to print selective areas of text and logos as an alternative to an iridescent diffraction grating derived ink or coating or hot or cold stamping foil, for use on labels, cartons, flexible packaging signs and displays.

An embossment comprising micro profiles which diffract light derive from a directly written knitted or woven iridescent effect which is entirely different from any known holographic, diffraction or straight line grating including dot matrix gratings derived from l.a.s.e.r light either by originating the pixels into photo resist or ablation to a plastic like polycarbonate or the like. The micro profiles are transferred onto one or both sides of the carrier film. Thereafter a layer of metal such as aluminium is applied by vacuum deposition or other well known applying method in a thickness in the range of 10 to 50 nm, especially 20 to 50 nm to one or both sides of the embossed surfaces. The former of which becomes embossed with areas of micro profiles which diffract light when the composite sheet is passed through a
release situation which causes the metal layer to be removed in particulate form to produce iridescent metal particles. The particles are collected in a non-reactive solvent. The iridescent particles are then broken into pigment particles having an average diameter between 10 to 50 microns and a thickness of 10 to 50 nm. Scanning electron-beam lithography is preferably used for the production of the knitted structure.

In order to better utilise this platelet pigment production process for diffractive effects, it is better to utilise diffractive patterns with less dependence on the rotation of the platelet, thus meaning that the diffracted angles are less dependent on the orientation of the platelet. The dependence of geometry in terms of rotational symmetry is how many times the structure will look identical after one full rotation.

For example, if a structure has N-fold rotational symmetry, it means that that the structure exhibits exactly the same geometry when rotated by an angle of 360°/N. For example, a one-dimensional grating will only have a two-fold rotational symmetry, hence if the grating is rotated, then the observer will only view the same geometry if the grating is rotated by a full 180° from its original position. Similarly, if we made a structure from two perpendicularly ruled one-dimensional gratings (or cross-gratings), then we would have 4-fold rotational symmetry where we would observe the same pattern every 90° of rotation. In order to improve the diffractive effects observed in ink and paint formulation where any given platelet will have random (or close to random) rotational alignment with respect to other platelet, diffractive geometries with higher orders of rotational symmetry are used. Regular periodic structures have translational symmetry in that they can be moved linearly until there is an exact match with a repeat cell. However, periodic structures have more limited rotational symmetry than some non-periodic structures. For example, it is believed that periodic structures have a maximum of 6-fold rotational symmetry. In recent years, there have been reports and descriptions of so-called "quasiperiodic" structures which do not exhibit translational symmetry but do exhibit rotational symmetry at a level traditionally not possible with regular periodic geometries. Quasiperiodic structures can exhibit a much higher degree of rotational symmetry, for example, 8-, 10- and 12-fold symmetry. A particular quasi-periodic pattern has 10-fold rotational symmetry and is known as Penrose tiling (R. Penrose, Bulletin - Institute of Mathematics and its Applications, vol. 10 (1974) 266), which has been described in US4,133,152 for use in a number of applications including games. According to the present invention the patterning described herein is not restricted to this type of structure, but rather any pattern with a high level of rotational symmetry. It is the intention of this disclosure to use a quasiperiodic structure with cell dimensions consistent with optical diffraction of visible and near-visible optical wavelengths, which when indented on thin films will create
layers with enhanced diffractive effects usable in platelet form. The high degree of rotational
symmetry expected in a quasiperiodic structure will mean that, to a much greater extent than
expected in any periodic structure, the optical diffraction pattern will be maintained despite
the expected randomness in the rotational alignment between platelets expected after the
application of ink and paints. An example of a quasiperiodic pattern is shown in Figure 7.
This particular example has 10-fold rotational symmetry and is an example of two-
dimensional Penrose tiling. In this representation, the dark points represent the part of the
microstructure which will be indented into the metallised layer to form the diffraction pattern.

The present invention will be explained in more detail on the basis of metallic platelets, but is
not limited thereto.

Fig. 1 is a block illustration of the process for production of the iridescent embossed metal
pigments of the present invention.

A carrier film covered with an anti-adhesive coating is embossed. A metal is vacuum
deposited on the embossed anti-adhesive coating. Then the metal is removed from the anti-
adhesive coating. The rough flakes are then mixed with a suitable solvent. The slurry can be
subjected to a centrifuging step, so that the solvent is removed to produce a cake of
concentrated flakes. The cake of concentrated flakes then can be let down in a preferred
vehicle, in a particle size control step, to be further sized and homogenized for final use of
the flakes in inks, paints or coatings, for example. Then the continuous process of forming
the embossed metal pigments starts again from the beginning, i.e. a metal is vacuum
deposited on the embossed anti-adhesive coating etc.

Fig. 2 is a schematic view of a process for production of the iridescent metal pigments of the
present invention.

Fig. 3 is a schematic view of an embossing process employing the principles of the present
invention.

Fig. 4 is a schematic view of an embossing process employing the principles of the present
invention.

Fig. 5 and 6 are schematic views of the process employing the principles of the present
invention.
Figure 7 shows an example of a quasiperiodic pattern.

Fig. 2 is a schematic view of the block illustration of the process shown in Fig. 1. The embossment is done using a shim and is illustrated in more detail in Fig. 3 and 4. A carrier film is covered with an anti-adhesive coating, which is embossed by using a shim having the desired microstructure, to create the desired microstructure in the anti-adhesive coating of the carrier film. In principle, the embossed anti-adhesive coating can be applied on both sides of the carrier film.

A particularly preferred embodiment of the present invention is shown in Fig. 5. In said embodiment a silicone covered roller A is metallised forming a thin film of metal. At the same time a pick up roller B is provided with a high tack adhesive via a high tack adhesive supply and application rollers C and D. That is, the high tack adhesive is continuously applied to the roller which in turn is contacted with the metallised carrier. This causes the aluminium layer to be transferred to the pick up roller B and to build alternating layers of adhesive and aluminium on the roller.

At the end of the process the pick up roller B is removed and washed in a solvent to remove the composite layers. The obtained metal particles are washed and concentrated if desired to a dispersion normally containing 10 to 20% pigment. The particles are then sized by vigorous stirring or ultrasonic treatment.

The roller A has a coating of silicone containing an embossment. This is done by casting a silicone sleeve and then sliding on to the roller (this can also be done as a silicone belt, see Fig. 6). As silicone has a non stick (anti-adherent) surface it is easy to transfer from.

In said embodiment the silicone covered roller is provided with an embossment, such as an holographic grating, or microprofiles derived from a directly written knitted or woven iridescent effect. Alternatively, the silicone covered roller can have a mirror finish. Then bright metal flakes having a smooth surface are obtained.

Anti-adhesive (non sticky) coating means a coating which enables vapour deposition of a metal, or dielectric material and the separation the metal, or dielectric material using a high tack adhesive.
Examples of the anti-adhesive (non sticky) coating are silicone/release coatings, polysiloxanes, microcrystalline waxes, or partially saponified montan waxes, wherein polysiloxanes, such as, for example, a hydroxylated polysiloxane, are preferred.

Examples of the high tack adhesive are acrylics, styrene-acrylonitrile polymers, polyesters, hotmelt and nitrocelluloses.

Embossing can be achieved using nickel shims. Alternatively, diamond cut and interference lithography can be used to create the embossment.

Another particularly preferred embodiment of the present invention is shown in Fig. 6.

Once the belt is in position in the vacuum deposition chamber the process can start. First a metal is vapourised to the surface of the silicone coated belt. Roller B is the take off roller which will grow in size as the metal is taken off. This is done by applying an adhesive to the surface of roller B via the application rollers C and D. Each time the roller B is coated with adhesive it will rotate and pick off the metal from the belt passing roller A. As the surface of the belt has a coating of metal roller B will take this off via the adhesive.

This method can also be applied for the production of non-holographic platelet-like materials, if a silicone sleeve/belt having a mirror finish is used.

At the end of the process the pick up roller is removed and washed in a solvent to remove the composite layers. The obtained metal particles are washed and concentrated if desired to a dispersion normally containing 10 to 20% pigment. The particles are then sized by vigorous stirring or ultrasonic treatment.

The carrier can be an embossed metal carrier, such as a metal belt, a rotating disk or cylinder. The diffractive grating can be produced by etching. Instead of metal a heat-resistant plastic, such as Capton® can be used.

In an embodiment of the present invention the apparatus and method described in US-A-4,321,087 is used for the preparation of the plan-parallel structures. Said embodiment is described on the basis of embossed aluminum flakes, but is not limited thereto.
According to the present invention the term "aluminum" comprises aluminum and alloys of aluminum. Alloys of aluminum are, for example, described in G. Wassermann in Ullmanns Enzyklopädie der Industriellen Chemie, 4. Auflage, Verlag Chemie, Weinheim, Band 7, S. 281 to 292. Especially suitable are the corrosion stable aluminum alloys described on page 10 to 12 of WO/00/12634, which comprise besides aluminum silicon, magnesium, manganese, copper, zinc, nickel, vanadium, lead, antimony, tin, cadmium, bismuth, titanium, chromium and/or iron in amounts of less than 20% by weight, preferably less than 10% by weight.

In a discontinuous process, if necessary, an embossment is applied to at least on side of a carrier sheet by a shim. In a particularly preferred embodiment of the present invention at least on side of the carrier sheet is first covered with an anti-adherent coating and an embossment is applied to the anti-adherent coating by a shim.

The embossed film is then passed through a roll coater where subsequently a layer of aluminum is vapor-deposited on anti-adherent coating in a typical PVD (Physical Vapor Deposition) process.

It is possible to arrange several separating agent and product vaporisers one after the other in the running direction of the carrier in the vaporisation zone. By that means there is obtained, with little additional outlay in terms of apparatus, a layer sequence of P + S + P, wherein S is the separating agent layer and P is the product layer. If the number of vaporisers is increased by two and the carrier speed is the same, twice the amount of product is obtained.

The separating agent (S) may be a laquer, a thermoplastic polymer described in US-B-6 398 999, such as acrylic or styrene polymers or mixtures thereof, an organic substance soluble in organic solvents or water and vaporizable in vacuo, such as anthracene, anthraquinone, acetamidophenol, acetylsalicylic acid, camphoric anhydride, benzimidazole, benzene-1,2,4-tricarboxylic acid, biphenyl-2,2-dicarboxylic acid, bis(4-hydroxyphenyl)sulfone, dihydroxanthraquinone, hydantoin, 3-hydroxybenzoic acid, 8-hydroxyquinoline-5-sulfonic acid monohydrate, 4-hydroxycoumarin, 7-hydroxycoumarin, 3-hydroxynaphthalene-2-carboxylic acid, isophthalic acid, 4,4-methylene-bis-3-hydroxynaphthalene-2-carboxylic acid, naphthalene-1,8-dicarboxylic anhydride, phthalimide and its potassium salt, phenolphthalein, phenothiazine, saccharin and its salts, tetraphenylmethane, triphenylene, triphenylmethanol or a mixture of at least two of those substances.
Sharply-featured continuous lines can be indented into the anti-adherent coating which act as borders between similarly-sized regions of metal layer in order and weakens the immediate neighbourhood of the metal layer which preferentially breaks in the later stirring or ultrasonic stage to improve the overall size homogeniety of the platelets.

The thickness of the deposited aluminum is critical to obtain the desired properties of the final pigments. Usually, the thickness is adjusted between 10 and 50 nm.

In the next step the embossed metalized film runs through a release enviroment were the embossed aluminium particles are separated from the film.

The obtained embossed aluminium particles are washed and concentrated if desired to a dispersion normally containing 10 to 20% pigment. The particles are then sized by vigorous stirring or ultrasonic treatment. Reference is made to Fig. 2.

In addition, the apparatus described in US6376018 and WO01/025500 can, in principal, be used for the production of the embossed aluminium particles.

Such an apparatus, adapted to the process of the present invention, comprises:
a rigid carrier rotatable about an axis and located in a vacuum chamber covered with an anti-adhesive coating, and optionally comprising an embossed coating, means for coating the (embossed) surface of said anti-adhesive coating of said carrier with at least one product layer,
means for stripping said product layer from said partial surface of said carrier, for example, by using a high-tack adhesive as described above, wherein transport of said partial surface between said coating means and said stripping means being effected through rotation of said carrier.
Said carrier is preferably located in a vacuum chamber and an intermediate separation for creating two pressure stages is provided between said means for coating with said product and said stripping means.
The carrier comprises an open or closed, rotationally symmetrical, rigid body.
The carrier comprises several open or closed, rotationally symmetrical, rigid bodies which rotate about a common axis or about several axes, or the carrier comprises several parallel discs of which at least one may be coated face-and-back by said coating means.
In said embodiment the process for producing the embossed aluminium flakes, comprises
1) coating the (embossed) surface of an anti-adhesive coating of a rigid carrier rotatable
about an axis and located in a vacuum chamber subsequently with an aluminium layer,
2) transporting said partial surface through rotation of said carrier subsequently to step 1),
3) removing said aluminum layer from said (embossed) surface of said carrier located in
said vacuum chamber subsequently to step II) in such a way that (embossed) aluminium
flakes are produced.

The anti-adhesive coating can be, for example, made of polysiloxane.

A knife blade disposed proximate to the surface of the drum can be used for scraping the thin
film structure off.

The use of embossed particles as security devices in a variety of applications like banknotes,
credit/debit cards, passports, tickets, visas, fiscal tax stamps, vehicle licences, postage
stamps, cheques/travellers cheques, gift vouchers, lottery tickets, passports, computer
software, letters of credit, government procurement documents, compact discs and DVD's
document security, anti-counterfeiting, brand protection and the like is known.

The possibility of counterfeiting decreased further by adding thermo- or photochromic dyes,
UV/IR fluorescent dyes, magnetic stripes etc. into an ink, comprising the embossed particles.

The embossed particles, which are characterised in that the embossment comprises micro
profiles derived from a directly written knitted or woven iridescent effect, or a diffraction
pattern with a greater than 6-fold degree of rotational symmetry, as exhibited in quasiperiodic
patterns, where the diffraction pattern has an average cell spacing consistent (50nm - 2000
nm) with the clear observation of decorative effects in the visible region of the human eye,
are new and form a further subject of the present invention.

The "master" used to create the (quasiperiodic) pattern may be formed using electron beam
lithography. Electron beam lithography is a known practise whereby a focussed electron
beam is scanned across a substrate in order to selectively etch across a surface coated with
a thin layer of material called a resist. The electron beam is used to selectively remove the
resist to provide a pattern with high spatial resolution of typically 10's of nanometres. This
pattern is then used to create replicas using electro-forming techniques, which are then used
to create a tool for the embossing of the aluminium layers, for example by using a roller embossing approach.

In addition, the present invention relates also to a (security) product comprising the embossed particles according to the present invention.

In preferred embodiment of the present invention the (security) product is based on paper, aluminium, or another opaque substrate.

The (security) product is preferably a banknote, passport, identification card, drivers license, compact disc or packaging.

In addition, the embossed particles of the present invention can be used for interrogation by laser or other spectrally narrow source to provide a distinct identification by the diffraction pattern formed. The exact diffraction pattern formed can be selected by choice of cell spacing and the wavelength of the source. This identification could be performed manually via a hand-held source or by machine.
Claims

1. A process for preparing platelet-like particles comprising the steps of:
   (a) providing a carrier covered with an anti-adhesive coating,
   (b) optionally applying an embossment directly to the anti-adhesive coating of the carrier,
   (c) depositing a layer of metal, or a dielectric material onto the surface of the anti-adhesive coating of the carrier sheet optionally having the embossment so that the layer conforms to the outside surface of the embossment,
   (d) passing the said carrier sheet with the said metal, or the said dielectric material through a release situation, which causes the said metal, or the said dielectric material to separate from the film,
   (e) disintegrating said separated metal, or dielectric material into platelet-like particles of desired size.

2. The process according to claim 1 for preparing platelet-like embossed particles comprising the steps of:
   (a) providing a carrier covered with an anti-adhesive coating,
   (b) applying an embossment directly to the anti-adhesive coating of the carrier,
   (c) depositing a layer of metal, or a dielectric material onto the surface of the anti-adhesive coating of the carrier sheet having the embossment so that the layer conforms to the outside surface of the embossment,
   (d) passing the said carrier sheet with the said metal, or the said dielectric material through a release situation, which causes the said metal, or the said dielectric material to separate from the film,
   (e) disintegrating said separated metal, or dielectric material into platelet-like embossed particles of desired size.

3. The process of claim 1, or 2, wherein the anti-adhesive (non sticky) coating is a silicone/release coating, a polysiloxane, a microcrystalline wax, or partially saponified montan wax.

4. The process of claim 1, or 2, wherein step (d) comprises the use of a high tack adhesive.
5. The process according to claim 1, wherein said step of disintegrating said separated metal, or dielectric material into platelet-like particles of desired size is performed by ultrasonic agitation.

6. An embossed particle characterised in that the embossment comprises micro profiles derived from a directly written knitted or woven iridescent effect, or a diffraction pattern with a greater than 6-fold degree of rotational symmetry, as exhibited in quasiperiodic patterns, where the diffraction pattern has an average cell spacing consistent (50nm - 2000 nm) with the clear observation of decorative effects in the visible region of the human eye.

7. The embossed particle according to claim 6, which is a metal particle.

8. The embossed particle according to claim 6, wherein the particle is an optical stack, or an optically variable multi layer thin film interference stack.

9. The embossed particle according to claim 6, which has an optically knitted micro structure having infinite areas of iridescent surface.

10. The embossed particle according to claim 6, wherein the metal is aluminum, silver, copper, gold, platinum, tin, titanium, palladium, nickel, cobalt, rhodium, niobium, stainless steel, nichrome, chromium, and compounds, combinations or alloys thereof.

11. The embossed particle according to claim 10, comprising aluminium, or an alloy thereof and having a thickness of 10 to 50 nm and a diameter in the range of 10 to 50 µm.

12. Use of the embossed particles according to any one of claims 6 to 11, in paints, in ink-jet printing, cosmetics, coatings, printing inks, plastics materials, in glazes for ceramics and glass, and in security printing.

13. A composition comprising the embossed particles according to any one of claims 6 to 11.

14. A (security) product comprising the embossed particles according to claim 6.
15. The (security) product of claim 14, which is a banknote, passport, identification card, drivers license, compact disc or packaging.

16. Use of the embossed particles according to claim 6 for interrogation by laser or other spectrally narrow source to provide a distinct identification by the diffraction pattern formed.
Fig. 2

Pigment

Vacuum Deposition Metallising

Embossment

Carrier Film covered with an anti-adhesive coating

Particulating

Finished Compound