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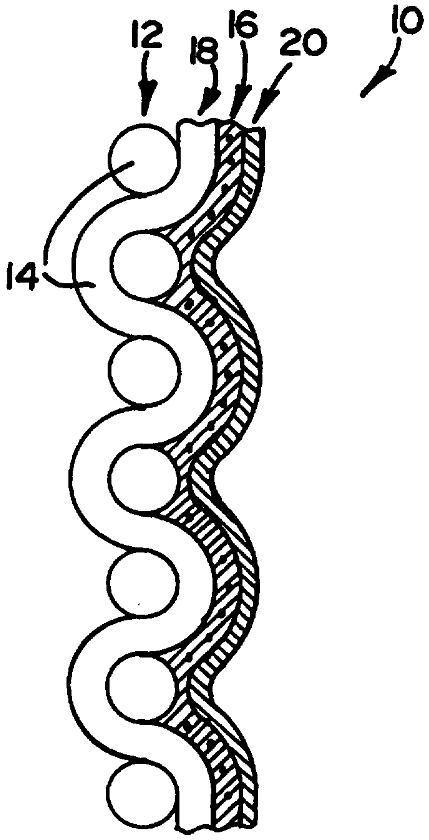
(54) Title: THE COATING OF MATERIALS

(57) Abstract

A method of fabricating a composite, coated material includes the steps of providing a base material, applying a layer of a low melting point metal to at least one surface of the base material and entraining particles of a wear-resistant material in a fluid stream and causing the fluid stream with the particles entrained therein to impinge on the, or each, metal layer such that a phase of the wear resistant material bonds to the metal layer.



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# THE COATING OF MATERIALS

**THIS INVENTION** relates to the coating of materials. More particularly, the invention relates to a composite, coated material and to a method of fabricating a composite, coated material.

A base material to be coated, in accordance with the invention, may be of the type which is susceptible to damage by the application of heat, by a high energy impact or by being pierced with a sharp or pointed object.

According to a first aspect of the invention, there is provided a method of fabricating a composite, coated material, the method including the steps of

providing a base material of the type described;

applying a layer of a low melting point metal to at least one surface of the base material; and

entraining particles of a wear-resistant material in a fluid stream and causing the fluid stream with the particles entrained therein to impinge on the, or each, metal layer such that a phase of the wear resistant material bonds to the metal layer.

The wear resistant material may comprise a ceramic or cermet (hereinafter the term "ceramic" is used in a broad sense to include a cermet).

The method may include, prior to the fluid stream impinging on the metal layer, removing thermal energy from the fluid stream. The thermal energy may be removed from the fluid stream via a hot gas separator which emits a gas jet at substantially right angles to a direction of flow of the fluid stream.

The base material to be coated may, in particular, be a textile and the method may thus include providing the base material in a web form, supporting the web in a tensioned manner over a plurality of rollers and feeding the web through a coating installation. At least one of the rollers may be adjustably mounted for controlling tension imparted to the web and for inhibiting the formation of wrinkles in the web.

Further, the method may include controlling the velocity at which the web moves through the coating installation. In addition, the method may include cooling the web to maintain the temperature of the web below a predetermined temperature, for example, approximately 60°C.

The method may include producing the low melting point metal by melting two different metals together, in an arc spraying system. The arc spraying system may be a closed nozzle arc spraying system. Further, the method may include atomizing the metal so produced into a fine particle stream which is applied to the base material.

A first cooling arrangement may be arranged downstream of the arc spraying system with a second cooling arrangement being arranged downstream of the hot gas separator.

The method may include applying the wear resistant material to the metal layer using a thermal spraying technique, preferably a high velocity oxygen fuel spraying technique or a plasma spraying technique.

Thus, the method may include entraining ceramic particles in the fluid stream using a high velocity oxygen fuel thermal spraying device.

Hence, the second cooling arrangement may be arranged downstream of the device.

The method may include causing the arc spraying system and the device to traverse the web, from one edge of the web to the other, at a predetermined velocity, to facilitate appropriate coating of the web.

The device used to deposit the ceramic on the web may be of the type which utilises both a gas and a liquid fuel. Thus, the method may include utilising a gas fuel to impart thermal energy to the ceramic particles and a liquid fuel to generate sufficiently high particle velocities to give the ceramic particles sufficient kinetic energy to bond with the metal layer.

The method may include extracting metal dust particles to inhibit settling of such dust particles on the base material and which may adversely affect the bonding or density of the applied coating.

According to a second aspect of the invention, there is provided a composite, coated material which includes

a base material of the type described; and

a coating applied to at least one surface of the base material, the coating including a metal portion comprised of a low melting point metal and a wear resistant portion of a wear resistant material.

The invention has particular application in the coating of cloth. Hence, the base material may be a textile comprising a plurality of interwoven fibres. The textile may be a high strength, flexible textile which is lightweight and energy absorbent.

The fibres may be selected from the group comprising natural materials, synthetic materials, metallic materials and combinations of these materials.

The metal of the metal portion of the coating may be selected so that a temperature of the base material, when the metal is applied, is retained below a predetermined value. Typically, the metal may be selected so that the temperature of the base material, when the metal is applied, is retained in the region of 60°C or below.

Thus, the metal of the metal portion of the coating may be selected from the group comprising zinc, tin, aluminium, copper, antimony, lead, and alloys thereof.

The wear resistant portion of the coating may comprise a ceramic, as defined.

The ceramic may be applied to the metal portion in a single phase where ceramic particles are at least partially embedded in the metal portion. Instead, the ceramic may be applied as a single, continuous phase as a separate layer to overlie the metal coating.

The invention is now described by way of example with reference to the accompanying diagrammatic drawings.

In the drawings:

Figure 1 shows a schematic view of a composite, coated material, in accordance with a first embodiment of the invention;

Figure 2 shows a schematic sectional view of a composite, coated material in accordance with a second embodiment of the invention; and

Figure 3 shows a schematic representation of a method of fabricating a composite, coated material.

Referring firstly to Figure 1 of the drawings, a composite, coated material, in accordance with a first embodiment of the invention, is illustrated and is designated generally by the reference numeral 10.

The coated material 10 comprises a base material in the form of a textile 12 comprising a plurality of interwoven fibres 14. Any suitable natural or synthetic fibres 14 may constitute the textile 12. Generally, the textile 12 is selected to have properties of high strength, energy absorbency, fluidity, lightweight and ease of manufacture. For example, the fibres, when synthetic, can be of a high strength polyethylene and aramid material where the coated material is to be used in body armour applications. However, the fibres 14 of the textile 12 could also be natural fibres such as cotton, wool, silk, or the like, and/or metallic fibres.

A low melting point metal layer 16 is applied to a surface 18 of the textile 12 to bond with the fibres 14. As will be described in greater detail below, the metal layer 16 is, normally, an alloy of various metals such as zinc, tin, aluminium, copper, antimony, lead, or the like. The metal layer 16 acts as a mechanical key for the textile 12 and further acts as a thermal barrier for the textile 12 when a wear resistant material 20 is applied to the metal layer 16.

In the embodiment illustrated in Figure 1 of the drawings, the wear resistant material 20 is a ceramic (as defined) which is applied in a single continuous phase or layer to the metal layer 16.

In the embodiment illustrated in Figure 2 of the drawings, where, with reference to Figure 1 of the drawings, like reference numerals referred to like parts, the wear resistant material 20 is in a single phase where individual particles 22 are at least partially embedded in the metal layer 16.

The wear resistant material is a pure ceramic such as $Al_2O_3$, $Al_2O_3$ $TiO_2$, $Al_2O_3$ MgO, $Al_2O$ $SiO_2$, $Al_2O_3$ $Cr_2O_3SiO_2$, $ZrO_2$ MgO, $ZrO_2$ CaO, $ZrO_2Y_2O_3$, $TiO_2$, $Cr_2O_3$, or the like. Instead, the ceramic is a hard metal phase cermet such as WC - Co, CrC NiCr, TiC NiCr, TiC FeCr, or the like. In addition, the ceramic could comprise combinations of the above materials.

Typically, the metal layer 16 has a coating thickness of approximately 5 to 100 $\mu$m and a specific density of 20 to 4000 g/m². When the wear resistant material 20 is in the form of a separate layer, as shown in Figure 1 of the drawings, the layer has a coating thickness of approximately 2 to 100 $\mu$m with a specific density of 2 to 1000 g/m².

Referring now to Figure 3 of the drawings, equipment for manufacturing the composite, coated fabric 10 is illustrated and is designated generally by the reference numeral 30. The equipment 30 includes a coating installation in the form of a booth 32 with dust extraction ports 34 defined therein. A base material, being the textile 12, to be coated is provided in the form of a web 36 which is fed into the coating booth 32. The web 36 is supported on a plurality of rollers 38. As illustrated, one of the rollers 38.1 is adjustable for maintaining tension in the web 36 so as to inhibit the formation of wrinkles in the web 36.

The equipment 30 includes a closed nozzle arc spraying system 40 having a first feed 42 for a first metal and a second feed 44 for a second metal. Further, the system 40 includes a high pressure compressed air feed 46 which atomises the molten, metallic particles into a fine particle stream 48 which is sprayed on to a surface of the web 36 travelling past the stream 48 in the direction of arrow 50. The speed of the web 36 is maintained at a constant velocity of approximately 1 to 5 m/s so that the metal layer 16 is applied in a substantially uniform manner to the surface of the web 36.

The metals used in the feeds 42 and 44 are copper and zinc base alloys which are melted in the system 40 to be sprayed on to the web 36.

In addition, cooling elements 52 and 54 are arranged downstream of the system 40 for spraying cooling fluid on to the web 36 to maintain it at a temperature below 60°c during the application of the metal layer 16.

Dust is extracted through the ports 34 to remove any alloy dust particles prior to their settling on the web 36 which could adversely affect the bonding or density of the coating.

The equipment 30 further includes a high velocity oxygen fuel thermal spraying device 56 for spraying the ceramic on to the metal layer 16. The device 56 is arranged downstream of the closed nozzle arc spraying system 40.

The system 40 is mounted on a carrier 58 and the device 56 is mounted on a carrier 60. The carriers 58 and 60 move in synchronization, to cause the particle stream 48 and a fluid stream 62 emitted from the device 56 to traverse the web 36 from one edge of the web 36 to the other. The device 56 includes a feed line 64 for feeding the hard ceramic, in particulate form, into the device 56. In addition, the device 56 has a gas feed line 66 and a liquid feed line 68 for feeding a gas and liquid fuel, respectively, into the device 56. Thus, the fluid stream 62 emitted from the device 56 comprises the gas, the liquid fuel and the ceramic particles entrained therein. The gas provides sufficient thermal energy to render the ceramic particles plastic while the liquid fuel generates high gas and particle velocities to give the ceramic particles sufficient kinetic energy to bond with the metal layer 16. To inhibit complete penetration of the metal layer 16 by the ceramic particles and thereby inhibiting damage to the textile web 36, a hot gas separator 70 is arranged downstream of an outlet of the device 56. A stream 72 emitted by the separator 70 intersects the fluid stream 62 at substantially right angles to the fluid stream 62. The stream 72 has the effect of reducing the thermal energy of the particles so as to inhibit penetration of the ceramic particles through the metal layer 16.

By appropriately generating extremely high particle velocities and controlling the particle size of the ceramic particles as well as their specific weights, the particles can pass through the stream 72 substantially undisturbed apart from the reduction in thermal energy thereof.

The gas used in the stream 72 is air, carbon dioxide or nitrogen. The same gases are used in the cooling arrangements 52 and 54.

To provide the required thickness of layers the carriers 58 and 60 traverse the web 36 at a speed of approximately two metres per minute which is controlled to provide the required consistency of coating.

It is a particular advantage of the invention that a process of coating fragile materials is provided whereby a wear resistant layer can be applied to the material with little likelihood of damaging the material. Further, a material coated in accordance with the invention shows resistance to heat and to penetration by sharp or pointed objects. In certain applications, to improve resistance to penetration by the sharp objects, the coated material is provided in a number of layers.

CLAIMS

1. A method of fabricating a composite, coated material, the method including the steps of

providing a base material of the type described;

applying a layer of a low melting point metal to at least one surface of the base material; and

entraining particles of a wear-resistant material in a fluid stream and causing the fluid stream with the particles entrained therein to impinge on the, or each, metal layer such that a phase of the wear resistant material bonds to the metal layer.

2. The method as claimed in Claim 1 which includes, prior to the fluid stream impinging on the metal layer, removing thermal energy from the fluid stream.

3. The method as claimed in Claim 1 or Claim 2 which includes providing the base material in a web form, supporting the web in a tensioned manner and feeding the web through a coating installation.

4. The method as claimed in Claim 3 which includes controlling the velocity at which the web moves through the coating installation.

5. The method as claimed in Claim 4 which includes cooling the web to maintain the temperature of the web below a predetermined temperature.

6. The method as claimed in any one of the preceding claims which includes producing the low melting point metal by melting two different metals together.

7. The method as claimed in Claim 6 which includes atomizing the metal so produced into a fine particle stream which is applied to the base material.

8. The method as claimed in any one of the preceding claims which includes applying the wear resistant material to the metal layer using a thermal spraying technique.

9. The method as claimed in Claim 8 in which the wear resistant material is a ceramic and in which the method includes entraining ceramic particles in the fluid stream using a high velocity oxygen fuel thermal spraying device.

10. The method as claimed in Claim 9 which includes utilising a gas fuel to impart thermal energy to the ceramic particles and a liquid fuel to generate sufficiently high particle velocities to give the

ceramic particles sufficient kinetic energy to bond with the metal layer.

11. The method as claimed in any one of the preceding claims which includes extracting metal dust particles to inhibit settling of such dust particles on the base material.

12. A composite, coated material which includes

a base material of the type described; and

a coating applied to at least one surface of the base material, the coating including a metal portion comprised of a low melting point metal and a wear resistant portion of a wear resistant material.

13. The coated material as claimed in Claim 12 in which the base material is a textile comprising a plurality of interwoven fibres.

14. The coated material as claimed in Claim 13 in which the textile is a high strength, flexible textile which is lightweight and energy absorbent.

15. The coated material as claimed in Claim 12 or Claim 13 in which the fibres are selected from the group comprising natural materials, synthetic materials, metallic materials, and combinations of these materials.

16. The coated material as claimed in any one of the preceding claims in which the metal of the metal portion of the coating is selected so that a temperature of the base material, when the metal is applied, is retained below a predetermined value.

17. The coated material as claimed in any one of Claims 12 to 15 inclusive in which the metal of the metal portion of the coating is selected from the group comprising zinc, tin, aluminium, copper, antimony, lead, and alloys thereof.

18. The coated material as claimed in any one of Claims 12 to 17 inclusive in which the wear resistant portion of the coating comprises a ceramic, as defined.

19. The coated material as claimed in Claim 18 in which the ceramic is applied to the metal portion in a single phase where ceramic particles are at least partially embedded in the metal portion.

20. The coated material as claimed in Claim 18 in which the ceramic is applied as a single, continuous phase as a separate layer to overlie the metal coating.

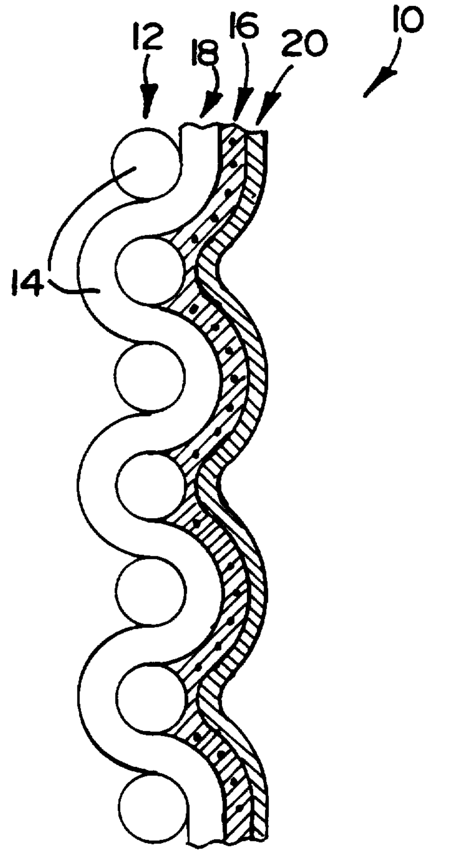


FIG 1

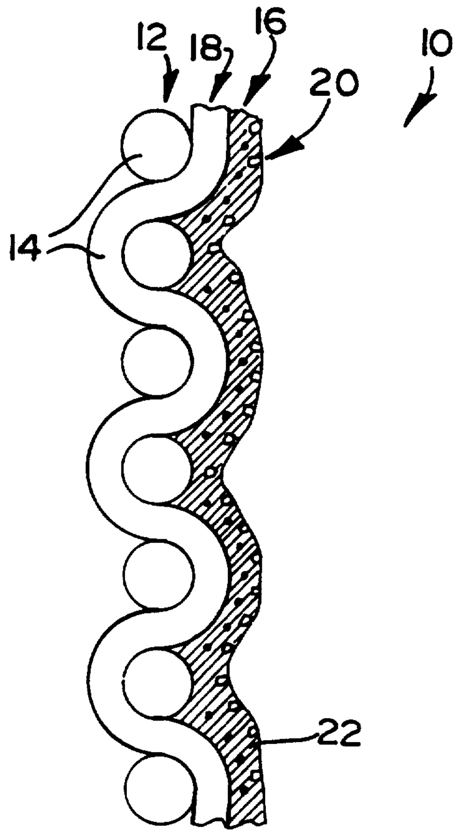


FIG 2

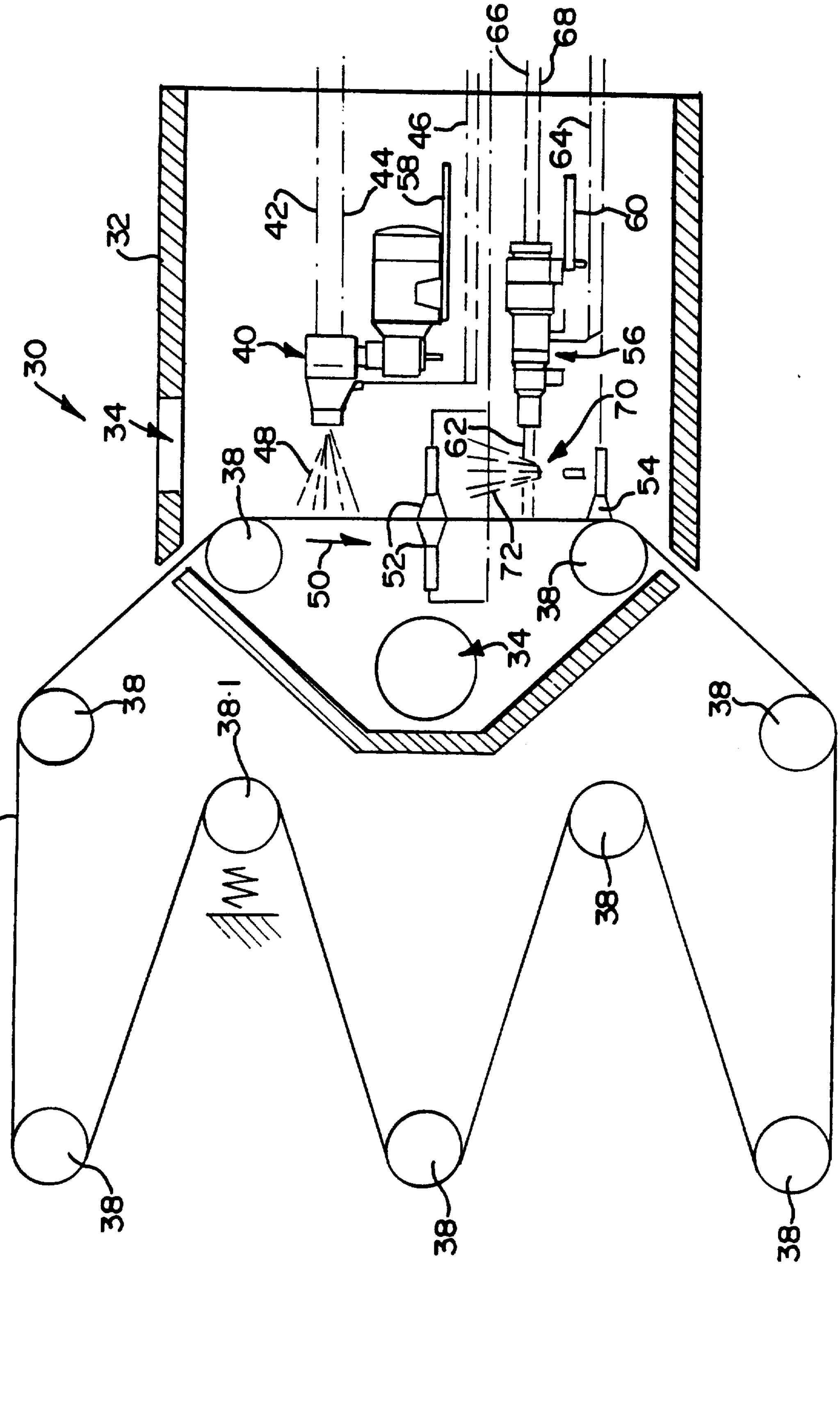


FIG 3

# INTERNATIONAL SEARCH REPORT

International Application No
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**A. CLASSIFICATION OF SUBJECT MATTER**
IPC 6 C23C28/00 C23C4/02 C23C4/14

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 C23C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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