

Substrates comprising information and methods for making same

Field of the invention

This invention relates to substrates containing information, for example, print, script, character(s), symbol(s), text, graphic or pictorial matter, colour, texture, photographic matter or other matter containing information and to methods for forming such substrates.

Background of invention

In general, glass and metal (e.g. aluminum, brass, stainless steel etc) in hard solid sheet/block form are the most widely used building materials in the interior and exterior of buildings.

Contemporary high-rise buildings are usually constructed of "curtain wall" systems. A curtain wall cladding system is a continuous vertical "curtain" comprised of glass, metal, stone, marble or composite assemblies. The curtain does not provide structural support, and is in fact itself supported by imbeds or supports at the face of a concrete or steel frame floor slab.

Use of glass in the curtain wall provides particular advantages by adding more vision to exterior walls, affording more light and more substantial views, which makes for a more pleasant for the occupants.

Despite these benefits, the curtain wall method of construction is not without its critics. Some argue that this building technique results in bare and denuded steel-and-glass "boxes" that are uninteresting and formulaic. This has resulted in a renewed exploration of the possibilities of innovative design and decoration. As a result, some architects have explored the possibility of creating freer, more imaginative structures that use modern building materials and decorative elements to create a variety of novel effects.

A decorative element that has been used in the past is metal tracery. Metal tracery could be used to provide a desired colourful graphic design to the exterior of "curtain-wall" constructions and thereby make the urban skyscraper visually different and more interesting. However, in reality, hefty production costs retard its development. Moreover, insufficient knowledge and inadequate supporting technical "know how" makes the use of this technique impossible.

Glass is one of the most versatile building materials with uses in contexts ranging from windows in homes and community buildings such as schools to modern office buildings. Glass can take many different forms for interior decorative design. It

can be spun finer than a spider web, or it can be a mirror weighing many tons. Most glass is clear, but can also be coloured as desired graphic design as well as integrated with functional device such as controllable animated lighting or sound.

It has been highly unlikely for heavy, large structural, thick block or sheet substrates (e.g. glass sashes with metal sheet/foil) to be printed using printing machinery due to the huge cost and limited capability of the machinery. Moreover such printing can be only carried out in plant during secondary production process and with unsatisfactory results. Furthermore, machine printing is totally ruled out in the case of vertical or cylindrical objects that have been installed (e.g. highway pillar, over-head bridge concrete wall and the like).

There is accordingly a need to find a single, cost-effective, direct printing machine or method, especially for use with vertical or cylindrical objects at the job site. However, current printing machines are limited by their capability and capacity. It is believed that, to date, there has been no satisfactory printing machinery or printing method that can achieve results of a satisfactory quality.

Applicants' British patent GB2294888 (the entire disclosure of which is specifically incorporated herein by reference) describes substrates containing information and methods for producing such substrates. These substrates contain information protected from damage comprising a substrate adjacent to which is a layer of adhesive, to which is adhered informative matter comprising print, script, graphic or pictorial matter or other matter containing information and, adjacent to the informative matter, a coating layer of transparent epoxy resin derived by the reaction of an epoxide of a polyvalent alcohol or phenol with a polyamine or polyamide. Whilst the method described in GB2294888 has wide application, there remains a need for a printing method that can be performed on large surfaces on site or on curved surfaces.

Summary of the invention

The present invention provides an information bearing substrate comprising a substrate adjacent to which is a layer of a cured, substantially transparent, thermoset plastic, said plastic layer comprising informative matter formed from an ink or a dye.

The information bearing substrate may comprise one or more further layers of cured substantially transparent thermoset plastic comprising informative matter formed from an ink or dye.

The present invention also provides a method for applying information to a substrate, the method comprising:

(a) providing a substrate, a liquid phase or intermediate phase substantially clear thermosetting plastic, and a transfer substrate having informative matter printed thereon;

(b) contacting the thermosetting plastic with the substrate and the informative matter of the transfer substrate; and

(c) removing the transfer substrate from the substrate when the thermosetting plastic has substantially cured to thereby transfer said printed informative matter from the transfer substrate to the substrate.

The method of the invention may include the further steps:

(d) contacting a liquid phase or intermediate phase thermosetting plastic with the cured thermoset resin layer of the previous step and a transfer substrate having informative matter printed thereon; and

(e) removing the transfer substrate when the thermosetting plastic has substantially cured to thereby transfer said printed informative matter to the substrate.

Detailed description of the invention

The substrate may be of any material including, but not limited to, wood, non-woven fabric, plastic, metal, glass, stone/rock, ceramic or concrete. Examples of metal include aluminum, brass and stainless steel. Examples of stone/rock include marble, and granite.

The substrate of the invention may comprise, or form part of, an article of manufacture. Examples of articles include, but are not limited to decorative monolithic laminated safety glass, photographic glass plaques, advertising electroluminescent graphic design panels. The substrate may be a building component or element. The substrate may be, or form part of, an architectural glass structure. The article may be an installed building component.

The substrate may be of any size or shape. For example, the substrate may range from a large, solid, structural substrate/product to a light, thin, flexible functional substrate/product. The substrate may be in the form of a sheet or panel. The substrate may have a rectilinear or curved shape. The building element may be installed on site. For example, it may be a glass panel of the type used in "curtain wall" construction of multi-story buildings.

The substrate may be glass suitable for window glazing, glass doors, and automotive applications (e.g. automobile window panes).

Preferably, the substrates (recipient of printed image) have a surface tension not less than about 7 dynes/cm to the thermoset plastic (in this case is Epoxy film

which has about 47 dynes/cm). More preferably, substrates have a higher surface tension greater than about 57 dynes/cm. Where required, the surface tension of a low surface energy material may be enhanced by surface treatment to improve bonding. Surface energy can be increased by any suitable method, for example, common methods, such as corona treatment, primer use, and anodizing, sputtering, or vacuum metallizing.

The substantially transparent thermoset(ing) plastic may be any suitable plastic, for example, a substantially transparent epoxy resin, polyurethane or polyester.

The substantially thermoset(ing) plastic may in the form a layer of a thickness between about 1,000 ~ 30 μm , preferably about 800 ~ 100 μm .

A transparent epoxy resin is particularly preferred. Generally, epoxy resins is formed by chemical reaction of an epoxide of a polyvalent alcohol or phenol, preferably bisphenol A) with any transparent polyamine or polyamide. Examples of suitable epoxides are described in GB 2294888. Any transparent polyamide or polyamine may be used to react with the epoxide. Such polyamines or polyamides may be aliphatic, cycloaliphatic or aromatic.

Epoxy resins are very versatile in formulation and mostly applicable in form of an adhesive. The epoxy resin may have a equivalent weight ranging from about 100 ~ 12,000 units, preferably below about 200 units or a viscosity between about 1,000 ~ 135,000 cps @ 25°C, preferably between about 1,500 ~ 2,000 cps @ 25°C. Preferably the epoxy resin has a critical surface tension in the liquid or solid phase of between about 45~49 dynes/cm.

The ink may be a printing ink. The printing ink may be a inkjet-printer ink or the like. Preferably the ink is a solvent-based inkjet printing ink.

The ink may also be a toner composition of the type used in monochrome or colour Copier/laser printers.

The informative matter may comprise one or more of script, character(s), symbol(s), text, graphic or pictorial matter, colour, texture, photographic matter or other matter containing information.

The transfer substrate may be a plastic film or sheet. The transfer substrate may optionally be treated to facilitate transfer of the informative matter from the transfer substrate to the receiving substrate. The treatment may be coating with a release agent, for example, a Silicon release agent, examples of which are supplied by companies such as Dow Coning, Toshiba, ShinEtsu etc.

In the method of the invention, the transfer substrate may be of any suitable shape, for example, in the form of a sheet or film. The transfer may be formed from a plastic. The transfer substrate may be a flexible transparent plastic film, for example,

polyethylene, polypropylene a biaxial oriented polyethylene terephthalate film or polyvinyl chloride film or the like.

The informative matter may be printed on the transfer substrate by any suitable method. Examples of suitable printing techniques are ink-jet or bubble-jet printing and laser printing and silk screen printing.

Embodiments of the invention.

The present invention will now be described in reference to particular embodiments. It will be appreciated that the present invention is not limited to these embodiments.

Epoxy resins are very versatile in formulation and mostly applicable in form of an adhesive. Preferably the epoxy has a low equivalent weight (eg below about 200 units) or viscosity (between about 1,000 ~ 5,000 cps @ 25°C) and 47 dynes/cm critical surface tension either in liquid or solid phase. It may be a UV activated Epoxy resin.

A digital image printed on a flexible transparent plastic film (specially coated transparent film, preferably transparent polyester Bi-axially oriented polyethylene terephthalate film (PET) or polyvinyl chloride (PVC) film (e.g. Folex/Epson/3M/Oyama), can be transferred to a substrate.

The substrate may be either a large, solid, structural substrate/product or a light, thin, flexible functional substrate/product. Preferably the substrates have a surface tension not less than 47 dynes/cm and preferably more to achieve good adhesion (higher surface tension, better cohesion) of the polymeric vehicle or carrier (Epoxy or polyepoxide is a thermosetting epoxide polymer that cures when mixed with a catalyzing agent or "hardener"). The transfer is a chemical reaction of polyepoxide as a resin (agent) and polyamide or polyamine as a catalyst (hardener). This is a chemical process of cross-linking i.e. polymerization in stages.

The ratio of polyepoxide to polyamide or polyamine depends on the viscosity, gel time, pot life and is usually recommended by formulator of resin manufacturer.

The stages of polymerization of an epoxide resin are:

A-Stage – liquid phase

An early stage in the reaction of epoxide resins with catalyst, in which the material is fusible and still soluble in certain liquids.

B-Stage - intermediate

An intermediate stage in the reaction of epoxide resins with catalyst, in which the material softens when heated and swells when in contact with certain liquids, but

may not entirely fuse or dissolve. The resin in an uncured state is usually in this stage, i.e. about 10 ~ 26 hours after the time of mixing (when adding catalyst into resin). Imprint mark/pattern or inserting microchip is possible at this stage.

C-Stage – solid phase

The final stage in the reaction of epoxide resins with catalyst, in which the material is relatively insoluble and infusible. The resins in a fully cured state are in this stage, i.e. about 7 days after time of mixing (adding catalyst into resin, the material will achieve full bond strength).

The substrate of the present invention, in its preferred embodiments, may possess at least one, preferably all, the following characteristic properties:

- Aesthetic finish surface with special effect;
- Water proof;
- Resistant to chemical solution;
- Tamper proof;
- Insulation to heat, electricity or sound;
- Short lead-time and cost saving for production process.

Example

An even layer of a mixture of polyepoxide with polyamine or polyamide is spread on a printed image of printout on a specially treated/coated transparent plastic film. The plastic film is then pressed against the substrate's surface to which it is intended to transfer the printed image to squeeze out excessive amount of mixture and ensure no bubbles trap as well as floating dirt. The desired thickness between 800 ~ 100 μm is attainable by adjusting the applied pressure.

The rate of curing of the epoxy resin may be accelerated by elevation of temperature by any suitable curing method, preferably by use of a microwave oven. At the C-Stage of polymerization, the plastic film is removed by peeling it off, leaving behind the original printed image on the substrate. The printed image is hence transferred from the transparent plastic film to the substrate. This transfer is obtainable largely depending on the cohesion (see below) between substrates.

Cohesion is the molecular force of attraction between unlike materials, i.e. either polyester or PVC film versus epoxy resin and epoxy resin versus the substrate. It is determined by the surface tension of the said material. The higher the surface tension, the greater the molecular attraction and the lower the surface tension, the weaker the attractive force. To enhance the surface tension, surface treatment may be required for some low surface energy material. Surface energy

can be increased by common methods of corona treatment, primer used, and anodizing, sputtering, or vacuum metallizing.

Taking advantages of versatility of epoxy resin, especially from liquid ~ intermediate ~ solid phase and doing loop of process, a desirable graphic design is achievable with aesthetic appearance and special effect, e.g. 3D effect, imprint.

CLAIMS

1. An information bearing substrate comprising a substrate adjacent to which is a layer of a cured substantially transparent thermoset plastic, said plastic layer comprising informative matter formed from an ink or a dye.
2. An information bearing substrate according to claim 1, wherein the informative material is selected from one of more of script, character(s), symbol(s), text, graphic or pictorial matter, colour, texture, photographic matter or other matter containing information,
3. An information bearing substrate according to claim 1 or claim 2, wherein the substrate is selected from wood, non-woven fabric, plastic, metal, glass, stone/rock, ceramic or concrete.
4. An information bearing substrate according to claim 3, wherein the substrate is a building element or structure.
5. An information bearing substrate according to claim 3, wherein the substrate is an advertising specialty component or article of manufacture.
6. An information bearing substrate according to any one of the preceding claims, wherein the thermoset plastic is an epoxy resin.
7. An information bearing substrate according to any one of the preceding claims, wherein the ink is a printing ink.
8. An information bearing substrate according to claim 7, wherein the ink is a jet-printer ink.
9. An information bearing substrate according to claim 7, wherein the ink is a copier/laser printer toner.
10. An information bearing substrate according to any one of the preceding claims which contains at least one further layer of a cured substantially transparent thermoset plastic, said plastic layer comprising informative matter formed from an ink or a dye.

11. A method for applying information to a substrate comprising:
 - (a) providing a substrate, a liquid phase or intermediate phase substantially transparent thermosetting resin, and a transfer substrate having informative matter printed thereon;
 - (b) contacting the thermosetting resin with the substrate and the informative matter of the transfer substrate; and
 - (c) removing the transfer substrate from the substrate when the thermosetting resin has substantially cured to thereby transfer said printed informative matter from the transfer substrate to the substrate.
12. A method according to claim 11, wherein the informative material is as defined in claim 2.
13. A method according to claim 11 or claim 12, wherein the informative material has been printed on the transfer substrate by inkjet printing or laser printing.
14. A method according to claim 11 or claim 12, wherein the substrate is as defined in claim 3 or claim 4.
15. A method according to any one of claims 11 to 14, wherein the thermosetting resin is an epoxy resin.
16. An information bearing substrate according to claim 14, wherein the epoxy resin has a viscosity between about 1,500 ~ 2,000 cps at 25°C.
17. A method according to any one of claims 11 to 16, wherein the transfer substrate is a plastic film.
18. A method according to claim 17, wherein the plastic film is a biaxially oriented polyethylene terephthalate film or polyvinyl chloride film or the like.
19. A method according to any one of claims 11 to 18, further comprising the steps:
 - (d) contacting a liquid phase or intermediate phase thermosetting plastic with the cured thermoset resin layer of the previous step and a transfer substrate having informative matter printed thereon; and

(e) removing the transfer substrate when the thermosetting plastic has substantially cured to thereby transfer said printed informative matter to the substrate; and

(f) optionally repeating steps (d) and (e) one or more times.

20. An information bearing substrate according to any one of claims 1 to 10 produced by the method of any one of claims 11 to 19.