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(54) METHOD FOR LAMINATING A MATERIAL LAYER ONTO A TRANSPARENT SUBSTRATE

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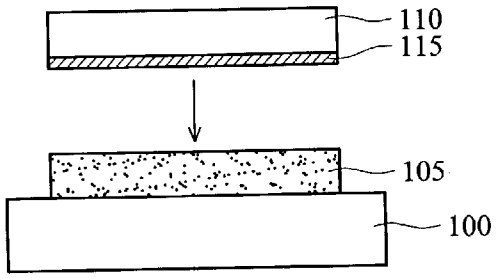
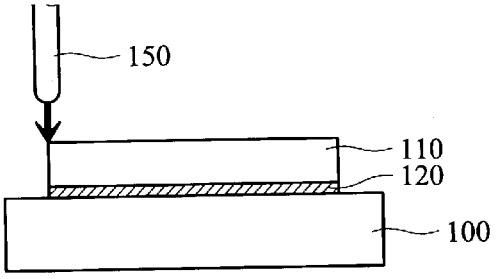
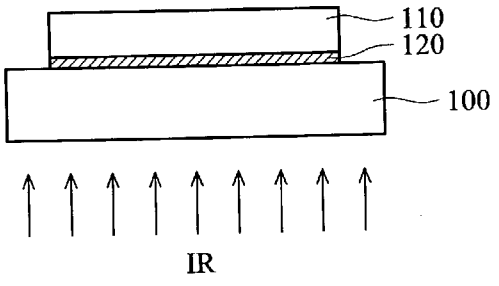
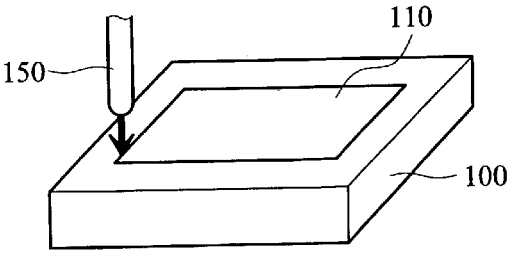
(57) **ABSTRACT**

A method for laminating a material layer onto a transparent substrate. The method includes the steps of: providing a transparent substrate having an amorphous silicon layer formed thereon; forming an infrared absorbent metal layer on the material layer; inverting the material layer to laminate the metal layer onto the amorphous silicon layer; and exposing the metal layer and the amorphous silicon layer to infrared light to cause a metal silicide producing reaction and thus laminate the material layer and the transparent substrate.









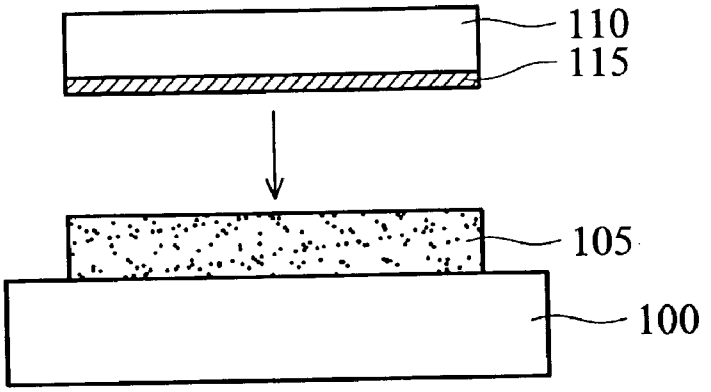


FIG. 1A

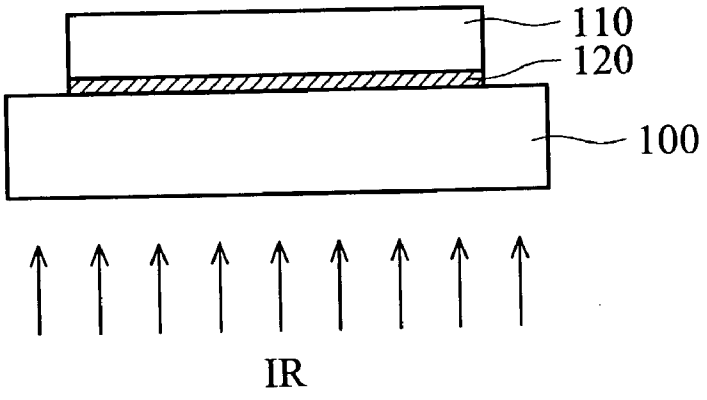


FIG. 1B

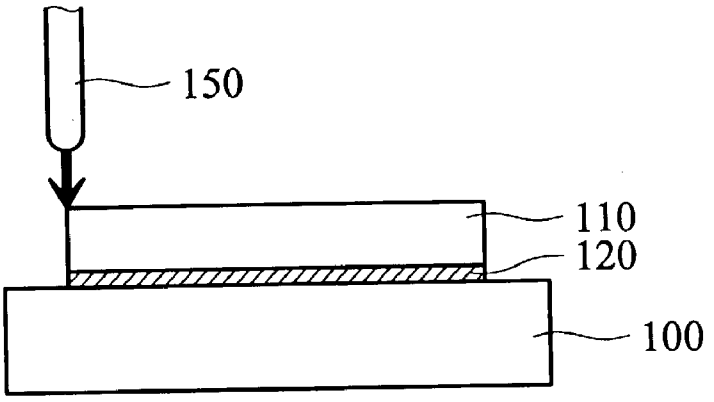


FIG. 1C

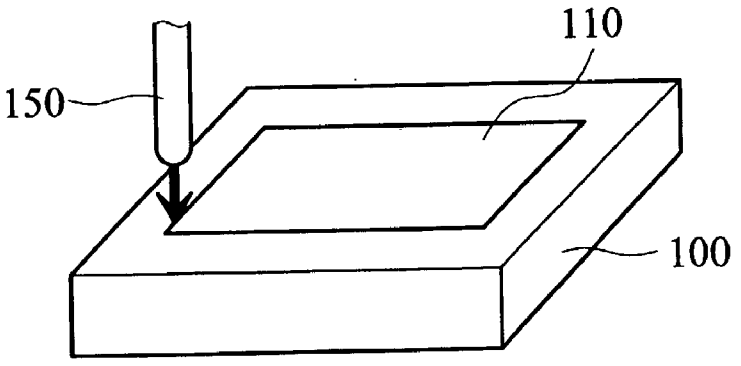


FIG. 1D

METHOD FOR LAMINATING A MATERIAL LAYER ONTO A TRANSPARENT SUBSTRATE

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The present invention relates to a lamination method for a transparent substrate, and in particular to a method for laminating material layers onto transparent substrates.

[0003] 2. Description of the Related Art

[0004] In addition to developing flat panel displays with greater display areas, the lighter, thinner, and more flexible characteristics of flat panel displays have also become desirable. One current trend is to substitute glass substrates with plastic substrates. However, many problems, such as low T_g, arise when using plastic substrates, which hinder the required high temperature process, resulting in poor panel performance. Moreover, plastic substrates are poorly suited to the manufacturing process, which induces severe stress, static and large thermal expansion coefficient. Other alternatives of substrate materials include metal, or metal alloy, such as aluminum, titanium or similar. Use of these substrate materials have the advantages of light weight, flexibility, high melting point, no static, lower thermal expansion coefficient, and lower cost. Therefore, these materials demonstrate great potential for use as substrates in flexible reflective panel displays. However, these flexible metal substrates cannot be incorporated into the current process and equipment. Glass must be used as a carrier, which is problematic as it requires temporary lamination of metal with glass, which must be separated in a subsequent step.

[0005] Current methods for temporary lamination mostly use a high molecular gel, which due to its poor resistance to high temperature, is not suitable for laminating metal and glass. Another lamination material for metal and glass is high temperature silver gel. Coating silver gel, however, is difficult and is not cost effective. As a result, silver gel is not a satisfactory laminating material.

[0006] Hence, there is a need for a novel lamination material and method for metal and transparent substrates.

SUMMARY OF THE INVENTION

[0007] Accordingly, an object of the invention is to provide a method for laminating a material layer onto a transparent substrate.

[0008] Another object of the invention is to provide a novel lamination method for combining a material layer, such as metal, ceramic, nanomaterial or other material onto transparent substrates with current method.

[0009] In order to achieve the above objects, the invention utilizes the heat produced by a metal layer absorbing infrared to chemically bond with an amorphous silicon layer to achieve tight adhesion. That is, when a non-infrared absorbing material is formed on a glass or other transparent substrate, an infrared absorbent thin film, such as Ni, Au, Ag, Pt, Mo, Ta, W, Ti or Co is firstly formed on the material layer. Lamination is then performed. These metals absorb infrared light and generate heat to form metal silicide with an amorphous silicon layer. In addition, the melting points of these metal layers are high enough to withstand the process temperature. This lamination method is effective as it does not require an additional gel material, or coating machine. Furthermore, the lamination method of the invention can be temporary or permanent, hence it is highly applicable in various applications.

[0010] A major feature of the invention is the formation of an amorphous silicon layer on a transparent substrate, followed by lamination with a material layer having a metal layer formed thereon. The metal layer and the amorphous silicon layer are then exposed to an infrared heater (such as a rapid thermal process) or a laser, because a transparent substrate and amorphous silicon do not absorb infrared light, but a metal layer will. As a result, the metal layer reacts with the amorphous silicon layer to form a tight bond, and allow follow-up processes to be efficiently performed. Conventional etching or laser cutting can be performed to detach the metal layer from the transparent substrate.

[0011] The method of the invention comprises the following steps of providing a transparent substrate having an amorphous silicon layer formed thereon; forming a metal layer that absorbs infrared on the material layer; inverting the material layer to laminate the metal layer onto the amorphous silicon layer; and exposing the metal layer and the amorphous silicon layer to infrared light to cause a metal silicide producing reaction, thus laminating and forming a bond between the material layer and the transparent substrate.

[0012] Examples of material layers are metal, ceramic, nanomaterial or other composite material; the transparent substrate can be glass, quartz, synthetic quartz, $LiNbO_3$ or $LiTaO_3$.

[0013] A detailed description is given in the following embodiment with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The present invention can be more fully understood by reading the subsequent detailed description and examples with references made to the accompanying drawings, wherein:

[0015] **FIGS. 1A-1D** are cross sections of the embodiment of the invention;

DETAILED DESCRIPTION OF THE INVENTION

[0016] As shown in **FIG. 1A**, a transparent glass substrate **100** having an amorphous layer **105** formed thereon is provided. In this embodiment, a glass substrate is used, but other materials, such as quartz synthetic quartz, LiNbO3 or LiTaO3 may also be used. Another material layer **110** having a metal layer **115** formed thereon is provided. The material layer in this embodiment is a metal foil. Other materials that cannot be formed directly on a glass substrate, such as ceramic, nanomaterial or other composite materials are also applicable. The metal layer used in this embodiment is Ni, or another infrared absorbent metal, such as Au, Ag, Pt, Mo, Ta, W, Ti, or Co.

[0017] Next, as shown in **FIG. 1B**, insertion of the material layer **110** to laminate the metal layer **115** onto the amorphous layer **105**, is followed by exposure to infrared light. During the exposure, the amorphous layer **105** and the

metal layer **115** react to form metal silicide **120**. Preferably the wavelength of the infrared light is 0.7~1.5 μm. In this step of the procedure, the material layer and the transparent glass substrate are bonded by the high melting point metal silicide, thus the purpose of this invention, temporary lamination onto a glass substrate, is achieved.

[**0018**] Optionally, after the process described above, wet etching or laser cutting can be performed to separate the material layer from the glass substrate. Preferably wet etching is performed to remove the metal silicide. MoSi1, WSi_2, $TiSi_2$ can be removed by NH_3/H_2O_2; $TaSi_2$, $CoSi_2$, $NiSi_2$ can be removed by H_2SO_4/H_2O; PtSi can be removed by HCl/HNO_3.

[**0019**] **FIG. 1C** is a cross section of the material layer **110** being removed by laser cutting, where **150** represents the laser cutter. **FIG. 1D** is an exploded view of the laser cutting to remove the material layer **110**.

[**0020**] According to the lamination method provided in this invention, no additional gel material or coating machine is required, thereby considerably reducing production cost. Moreover, this lamination method can be used for temporary, permanent, or local lamination. The invention provides a novel solution for laminating materials that cannot be laminated onto transparent substrates. The laminated product exhibits good resistance to high process temperature, and the close bonding between the material and the substrate also meet the requirements of the process. As a result, this method is highly applicable in industry.

[**0021**] While the invention has been described by way of example and in terms of the preferred embodiments, it is to be understood that the invention is not limited to the disclosed embodiments. To the contrary, it is intended to cover various modifications and similar arrangements (as would be apparent to those skilled in the art). Therefore, the scope of the appended claims should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements.

What is claimed is:

1. A method for laminating a material layer onto a transparent substrate, comprising:

providing a transparent substrate having an amorphous silicon layer formed thereon;

forming an infrared absorbent metal layer on the material layer;

inverting the material layer to laminate the metal layer onto the amorphous silicon layer; and

exposing the metal layer and the amorphous silicon layer to infrared light to cause a metal silicide producing reaction and thus laminate the material layer and the transparent substrate.

2. The method as claimed in claim 1, further comprising separating the material layer and the transparent substrate by etching or laser cutting.

3. The method as claimed in claim 1, wherein the transparent substrate is glass, quartz, synthetic quartz, $LiNbO_3$ or $LiTaO_3$.

4. The method as claimed in claim 1, wherein the material layer is s metal, ceramic, nanomaterial, or composite material.

5. The method as claimed in claim 2, wherein the etching is wet etching.

6. The method as claimed in claim 5, wherein the solution for wet etching is any solution that removes metal silicide.

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