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ENVIRONMENT-FRIENDLY DISPLAY MODULE AND ENVIRONMENT-FRIENDLY DISPLAY DEVICE

Abstract

An environment-friendly display module including a plastic module and a display module is provided. The display module is assembled to a region surrounded by the plastic module, and the display module and the plastic module are partially overlapped. The plastic module is made of post-industrial recycled (PIR) plastic or post-consumer recycled (PCR) plastic. An environment-friendly display device is also provided.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of China application serial no. 202410187190.6, filed on Feb. 19, 2024. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

[0002] The disclosure relates a display module and a display device; more particularly, the disclosure relates to an environment-friendly display module and an environment-friendly display device.

Description of Related Art

[0003] With the rapid advancement of technology, lightweight, energy-efficient, and portable smart information products have become omnipresent in our daily lives, and flat display modules are at the heart of this revolution. Among the flat displays, liquid crystal display (LCD) devices, known for their slim profiles, low power consumption, and lack of radiation pollution, are ideal for portable information products, such as laptops, personal digital assistants (PDAs), and mobile phones.

[0004] Worldwide regulations, major brands, and their supply chains are imposing increasingly stringent requirements on enterprises, particularly concerning environmental, social, and governance (ESG) aspects and carbon reduction. Failure to meet ESG or carbon reduction standards may potentially lead to the loss of orders or revocation of supplier qualifications.

[0005] For manufacturers striving to meet the stringent environmental regulations, in addition to reducing electricity and carbon footprints during production, designing products for optimal recyclability is also required. Hence, how to prioritize high recyclability and ease of disassembly throughout the design process has become a critical focus for technical personnel.

SUMMARY

[0006] The disclosure provides an environment-friendly display module and an environment-friendly display device complying with requirements for being lightweight, increasing the product recycling (reuse) ratio, reducing the costs, and so on through the special use and configuration of structural components.

[0007] According to an embodiment of the disclosure, an environment-friendly display module includes a plastic module and a display module. The display module is assembled to a region surrounded by the plastic module, wherein the display module and the plastic module are partially overlapped, and a material of the plastic module includes post-industrial recycled (PIR) plastic or post-consumer recycled (PCR) plastic.

[0008] According to an embodiment of the disclosure, an environment-friendly display device includes a control module, a back cover, a decorative bar, and the aforesaid environment-friendly display module. The control module is assembled to the plastic module and electrically connected to the display module. The back cover is assembled to the plastic module and enable the control module to be covered between the plastic module and the back cover. The decorative bar is assembled to the plastic module and the back cover and located at a bottom of the plastic module.

[0009] Several exemplary embodiments accompanied with figures are described in detail below to further describe the disclosure in details.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings are included to provide a further understanding of the disclosure, and are incorporated in and constitute a part of this specification. The drawings illustrate exemplary embodiments of the disclosure and, together with the description, serve to explain the principles of the disclosure.

[0011] FIG. 1 is a schematic view of an environment-friendly display device according to an embodiment of the disclosure.

[0012] FIG. 2A is an exploded view of some components of the environment-friendly display device in FIG. 1.

[0013] FIG. 2B is an exploded view of FIG. 2A from another viewing angle.

[0014] FIG. 3 is an exploded view of some components depicted in FIG. 2B.

[0015] FIG. 4A is an exploded view of some components of an environment-friendly display module.

[0016] FIG. 4B is the exploded view of FIG. 4A from another viewing angle.

[0017] FIG. 5 is a cross-sectional view of some components of an environment-friendly display device.

[0018] FIG. 6 is an exploded view of some components of an environment-friendly display module.

[0019] FIG. 7 is a front view of an environment-friendly display module.

DETAILED DESCRIPTION OF DISCLOSED EMBODIMENTS

[0020] FIG. 1 is a schematic view of an environment-friendly display device according to an embodiment of the disclosure. FIG. 2A is an exploded view of some components of the environment-friendly display device in FIG. 1. FIG. 2B is an exploded view of FIG. 2A from another viewing angle. With reference to FIG. 1, FIG. 2A, and FIG. 2B, in this embodiment, an environment-friendly display device **10** includes an environment-friendly display module **100**, a control module **200**, a back cover **300**, and a decorative bar **400**, where the control module **200** is assembled between the environment-friendly display module **100** and the back cover **300**, and the decorative bar **400** is assembled to the environment-friendly display module **100** and the back cover **300** and located at a bottom of the structure of the environment-friendly display module **100** and the back cover **300**.

[0021] FIG. 3 is an exploded view of some components depicted in FIG. 2B. With reference to FIG. 2A, FIG. 2B, and FIG. 3, in this embodiment, the environment-friendly display module **100** includes a plastic module PM and a display module DM that are combined with each other, where the plastic module PM includes a plastic back plate **110** and a plastic middle frame **130**, and the display module DM is assembled to a region surrounded by the plastic module PM. The display module DM and the plastic module PM are partially overlapped. A material of the plastic module PM includes PIR plastic or PCR plastic. The PIR plastic refers to plastic wastes generated from manufacturing and processing processes, and the wastes are transformed into new plastic products through recycling and reprocessing. The plastic wastes may come from the residues generated from cutting, molding, and mold production in the factory production process and products that are repaired, tested, or discarded on the production line. The PCR plastic refers to plastic products or packaging materials recycled from consumers after use and reused as new plastic products after recycling treatment. The plastics come from products recycled through recycling bins, recycling facilities, or other recycling channels after consumer use.

[0022] The plastic module PM includes a plastic back plate **110** and a plastic middle frame **130**, and the display module DM includes a metal bracket **120**, a light bar **140**, and a panel component **150**. After the plastic module PM and the display module DM are assembled, the control module

200, the decorative bar **400**, and the back cover **300** are sequentially assembled to the environment-friendly display module **100**. Here, the control module **200** is assembled to the plastic module PM and electrically connected to the display module DM. The back cover **300** is assembled to the plastic module PM, and the control module **200** is covered between the plastic module PM and the back cover **300**. The decorative bar **400** is assembled to the plastic module PM and the back cover **300** and located at a bottom of the plastic module PM to cover a portion of the display module DM. [0023] Specifically, the control module **200** includes a circuit board component **210** and a metal casing **220**. The circuit board component **210** is accommodated in the metal casing **220** and assembled along with the metal casing **220** to the plastic back plate **110** of the environment-friendly display module **100**, so that the circuit board component **210** is covered between the metal casing **220** and the plastic back plate **110**. The environment-friendly display module **100** further includes conductive fabrics **160** arranged along an opening of the metal casing **220** to form a closed outline. The metal casing **220** may be substantially attached to the plastic back plate **110** through the conductive fabrics **160**, and part of the conductive fabrics **160** is attached to the metal bracket **120**. Accordingly, the metal casing **220** may effectively provide electrical shielding for the circuit board component **210** covered by the metal casing **220** and may simultaneously serve as a grounding element for guiding the metal bracket **120**.

[0024] FIG. 4A is an exploded view of some components of an environment-friendly display module. FIG. 4B is the exploded view of FIG. 4A from another viewing angle. FIG. 5 is a cross-sectional view of some components of an environment-friendly display device, which is equivalent to cutting the environment-friendly display module **100** and the decorative bar **400** at the bottom of the environment-friendly display module **100** shown in FIG. 2B in half. With reference to FIG. 4A, FIG. 4B, and FIG. 5, in this embodiment, the light bar **140** (shown in FIG. 5) is, for instance, formed by a light emitting diode (LED) array, the metal bracket **120** has a support portion **121** and a bent portion **122**, the bent portion **122** extends from the support portion **121** and forms a groove **123** to accommodate the light bar **140**. The plastic back plate **110** is connected to the support portion **121**. The panel component **150** includes a light guide module **151** and a liquid crystal module **152**, where a portion of the light guide module **151** extends into the groove **123**, and the liquid crystal module **152** is disposed on the light guide module **151** and partially leans against the bent portion **122**. As shown in FIG. 4A, the plastic middle frame **130** includes a side wall **131** and a protruding platform **132** protruding from an inner side of the side wall **131**, and the liquid crystal module **152** is able to lean against and be connected to the protruding platform **132** through a connector **153** (as shown in FIG. 4B).

[0025] In addition, the environment-friendly display module **100** further includes a shielding mask **170** covering the outside of the bent portion **122** of the metal bracket **120**. As shown in FIG. 4B, a plurality of cables **152a** and a plurality of circuit board modules **152b** of the liquid crystal module **152** extend from a display surface **152c** of the liquid crystal module **152**, pass through the bent portion **122**, and extend to the support portion **121**, whereby the cables **152a** and the circuit board modules **152b** are substantially located between the metal bracket **120** and the shielding mask **170**.

[0026] At the same time, as shown in FIG. 5, the decorative bar **400** extends from the bottom to the display surface **152c** of the liquid crystal module **152**, and the liquid crystal module **152** is connected to the bent portion **122** through the connector **153** and located between the decorative bar **400** and the bent portion **122**. As shown in FIG. 2B or FIG. 3, the shielding mask **170** is configured to provide shielding for the circuit board modules **152b**. At the same time, the circuit board modules **152b** may extend to a back side of the plastic back plate **110** (turning away from the panel component **150**) through the cables **152a**, which is also conducive to the electrical connection of the circuit board modules **152b** to the control module **200**.

[0027] Besides, as shown in FIG. 5, in the metal bracket **120**, the support portion **121** provided in this embodiment further includes a first region A1 and a second region A2, where the second region A2 is connected between the first region A1 and the bent portion **122**, the first region A1 is

configured to support a portion of the plastic back plate **110**, and the second region **A2** is configured to support a portion of the light guide module **151**. Here, compared to a recessed structure applied to support the plastic back plate **110**, the support portion **121** further has a plurality of protrusions **121a** located in the second region **A2**, and the protrusions **121a** support the light guide module **151** in at least one of a surface contact manner and a line contact manner. [0028] FIG. **6** is an exploded view of some components of an environment-friendly display module. FIG. **7** is a front view of an environment-friendly display module, where Cartesian coordinates X-Y-Z are added for the convenience of component description. With reference to FIG. **5** to FIG. **7**, in this embodiment, the plastic back plate **110** has a rectangular outline and a top side **E1**, a bottom side **E2**, a left side **E3**, and a right side **E4** (where the left side **E3** and the right side **E4** are illustrated at a viewing angle shown in FIG. **7**), the top side **E1** and the bottom side **E2** are opposite to each other, and the left side **E3** and the right side **E4** are opposite to each other. Here, the X-axis is considered as a transverse direction of the plastic back plate **110**, and the Y-axis is considered as a longitudinal direction of the plastic back plate **110**. As shown in FIG. **6**, the metal bracket **120** is assembled to the bottom side **E2** of the plastic back plate **110**, the plastic middle frame **130** is in a U shape, an opening of the U-shaped plastic middle frame **130** faces the bottom side **E2**, and the plastic middle frame **130** is assembled to and surrounds at least a portion of the plastic back plate **110** and the metal bracket **120**. The light bar **140** is assembled into the groove **123** of the metal bracket **120**, so that the light guide module **151** partially extending into the groove **123** as shown in FIG. **4A** may correspondingly receive light generated by the light bar **140** and project the light toward the liquid crystal module **152**.

[0029] In this embodiment, the plastic middle frame **130** has a plurality of positioning posts **134**, and the plastic back plate **110** has a plurality of positioning holes **H1**, **H2**, and **H3**. The positioning posts **134** pass through and are positioned at the positioning holes **H1-H3**. To be specific, the positioning holes **H1-H3** provided in this embodiment are appropriately varied according to different positioning requirements. As shown in FIG. **7**, the positioning hole **H1** is an expansion hole, and an expansion direction of the positioning hole **H1** is parallel to the X-axis. The positioning hole **H2** is an expansion hole as well, and an expansion direction of the positioning hole **H2** is parallel to the Y-axis. The positioning hole **H3** is a round hole for the positioning posts **134** to directly pass through. As such, in addition to the positioning hole **H3** for the direct passage of the positioning posts **134**, connecting the positioning posts **134** to various types of expansion holes (i.e., the positioning holes **H1** and **H2**) enables effective accommodation of size tolerance arising from plastic component variations in the manufacturing process, so that the component assembly process may be performed more convenient and streamlined while meeting the positioning requirements.

[0030] Besides, as shown in FIG. **7**, among the plastic back plate **110**, the plastic middle frame **130**, and the metal bracket **120**, the combination strength of the overlapping parts of the components may be enhanced by allowing the positioning posts **134** to pass through the metal bracket **120** and be positioned at the positioning holes (e.g., the positioning holes **H1** and **H3** adjacent to the bottom side **E2**) of the plastic back plate **110**.

[0031] In this embodiment, the plastic middle frame **130** further includes a platform **133** extending from the side wall **131** and two overflow tanks **133a**. The platform **133** is situated between the two overflow tanks **133a**, and the plastic back plate **110** may be connected to the platform **133** using an adhesive, while the two overflow tanks **133a** serve as adhesive overflow reservoirs. As shown in FIG. **6**, the platform **133** and the overflow tanks **133a** extend in a U shape along with the main structure of the plastic middle frame **130**, thus facilitating connection to the top side **E1**, the left side **E3**, and the right side **E4** of the plastic back plate **110**. Additionally, as shown in FIG. **5**, the bottom side **E2** of the plastic back plate **110** may be bonded to the support portion **121** of the metal bracket **120** using an adhesive.

[0032] Since the plastic back plate **110** and the plastic middle frame **130** provided in this

embodiment are made of the PIR plastic or the PCR plastic, it should be mentioned that this choice of materials contributes to an improved recyclability (reusability) ratio for the environment-friendly display module **100** (and the environment-friendly display device **10** using the display module **100**). Specifically, in this embodiment, the plastic back plate **110** and the metal bracket **120** are partially overlapped along the longitudinal direction (the Y-axis direction shown in FIG. 7); in this arrangement a portion of the plastic back plate **110** not overlapped with the metal bracket **120** has a first width W1 along the longitudinal direction, the metal bracket **120** has a second width W2 along the longitudinal direction, and $W2/(W1+W2) \leq 1/4$. Here, the width ratio of the metal bracket **120** is designed to meet the heat dissipation requirements of the light bar **140** and minimize the use of metal materials to increase the recyclability ratio of the products, as mentioned earlier.

[0033] In other words, the key structural components of the environment-friendly display module **100** (and the environment-friendly display device **10**) are the plastic back plate **110** and the plastic middle frame **130**, and the metal bracket **120**, composed of metal, is intentionally minimized structurally, accounting for less than or equal to one quarter of the overall structure. This deliberate reduction in the proportion of the metal bracket **120** allows the environment-friendly display module **100** (and the environment-friendly display device **10**) to prioritize the use of recyclable materials, particularly by increasing the proportion of the plastic components. Consequently, the recycling ratio of the mechanism components may exceed 75%, and the overall recycling ratio of the product (i.e., the environment-friendly display device **10**) may surpass 50%, which enables manufacturers to meet ESG standards or carbon reduction (carbon neutrality) standards.

[0034] Besides, the increased use of the plastic components results in a significant reduction in the overall product weight and related manufacturing processes and costs. Particularly, the plastic back plate **110** provided in this embodiment is cut from a rolling plate material, thus effectively preventing warping of the plastic back plate **110** caused by injection molding processes. Simply put, as the environmental-friendly display device **10** increases in size and demands thinness, existing plastic injection molded structural components face challenges in maintaining structural strength and flatness (or planarity), and warping occurs frequently due to the expanded surface area. Therefore, larger plastic structural components necessitate the metal components to achieve the required structural strength. However, this approach impedes a significant increase in the product recyclability. Accordingly, in this embodiment, the plastic back plate **110** made by cutting the rolling plate material is adopted to effectively reduce warping and maintain it below 1 mm. Therefore, on the conditions of meeting the structural strength, reducing the manufacturing costs, and reducing weight, larger structural components may be provided without sacrificing the recyclability of the material in the environment-friendly display module **100** (and the environment-friendly display device **10**).

[0035] To sum up, in one or more embodiments of the disclosure, in the display module and the display device, the existing metal frame is effectively replaced by the plastic back plate and the plastic middle frame. That is, apart from assembling the metal bracket to the bottom side of the plastic structure to accommodate the light bar and meet the heat dissipation requirements, a large proportion of the main structure is replaced with plastic parts, thus effectively reducing product weight, simplifying the manufacturing process, and reducing the manufacturing costs on the premise of maintaining the structural strength. More importantly, the plastic back plate and the plastic middle frame are respectively made of the PIR plastic or the PCR plastic, whereby the recyclability (reuse) ratio of the product is improved, and the ESG corporate requirements for environmental protection and carbon reduction are satisfied.

[0036] Here, the plastic back plate, which constitutes the largest area among the structural components, is shaped by cutting the rolling plate material, which not only addresses flatness (or planarity) but also reduces the degree of warping effectively. Conversely, the volume occupied by the metal bracket is less than a quarter of the total volume. This proportion allows the display module to employ recyclable materials for all other structures except for the metal bracket.

Consequently, the requirements of modern enterprises for ESG or carbon reduction may be satisfied through the design and use of the recyclable materials and the environmental protection materials.

[0037] To sum up, in the environment-friendly display module and the environment-friendly display device having the environment-friendly display module provided in one or more embodiments of the disclosure, the plastic module and the display module are assembled and combined, and the plastic module is made of the PIR plastic or the PCR plastic. This plastic module serves as the primary structure supporting the display module. Accordingly, through the extensive use of plastic structural components, the recyclability of the products provided in one or more embodiments of the disclosure is enhanced, and the products align with contemporary corporate requirements for compliance with ESG standards and carbon reduction through environmentally friendly materials in response to the concerns of recyclability. In addition to the increase in the recycling ratio, the plastic module effectively replaces the existing metal structural components and may further achieve benefits of reducing product weight, simplifying product manufacturing processes, lowering manufacturing costs, and so on.

[0038] Although the disclosure has been described above through embodiments, the embodiments do not serve to pose any limitation in the disclosure. Those with ordinary knowledge in the pertinent technical field are able to make some modifications to the disclosed embodiments without departing from the spirit and scope of the disclosure, and therefore the protection scope provided in the disclosure shall be determined by the following claims and their equivalents.

Claims

1. An environment-friendly display module, comprising: a plastic module; and a display module, assembled to a region surrounded by the plastic module, wherein the display module and the plastic module are partially overlapped, and a material of the plastic module comprises post-industrial recycled plastic or post-consumer recycled plastic.
2. The environment-friendly display module according to claim 1, wherein the plastic module comprises a plastic back plate and a plastic middle frame assembled to each other, and the plastic middle frame surrounds a portion of the plastic back plate.
3. The environment-friendly display module according to claim 2, wherein the plastic middle frame is in a U shape and adjacent to a top side, a left side, and a right side of the plastic back plate, an opening of the U shape faces a bottom side of the plastic back plate, the top side and the bottom side are opposite to each other, and the left side and the right side are opposite to each other.
4. The environment-friendly display module according to claim 3, wherein the plastic back plate is formed by cutting a rolling plate material.
5. The environment-friendly display module according to claim 2, wherein the display module comprises a metal bracket, a light bar, and a panel component, the metal bracket is assembled to a bottom side of the plastic back plate, the light bar is disposed on the metal bracket, and the panel component is disposed in a region formed by the plastic back plate, the metal bracket, and the plastic middle frame.
6. The environment-friendly display module according to claim 5, wherein the plastic back plate and the metal bracket are partially overlapped along a longitudinal direction, one portion of the plastic back plate not overlapped with the metal bracket has a first width $W1$ along the longitudinal direction, the metal bracket has a second width $W2$ along the longitudinal direction, and $W2/(W1+W2) \leq 1/4$.
7. The environment-friendly display module according to claim 5, wherein the plastic middle frame has a plurality of positioning posts, the plastic back plate has a plurality of positioning holes, and the positioning posts pass through and are positioned at the positioning holes.
8. The environment-friendly display module according to claim 7, wherein the plastic back plate

has a rectangular outline, part of the positioning holes is respectively an expansion hole, and an expansion direction of the expansion holes is parallel to at least one of a longitudinal direction and a transverse direction of the rectangular outline.

9. The environment-friendly display module according to claim 7, wherein the plastic back plate and the metal bracket are partially overlapped, and part of the positioning posts passes through the metal bracket and is positioned at part of the positioning holes of the plastic back plate.

10. The environment-friendly display module according to claim 2, wherein the plastic middle frame comprises a side wall, a platform extending from the side wall, and two overflow tanks, the platform is located between the two overflow tanks, and the plastic back plate is connected to the platform.

11. The environment-friendly display module according to claim 10, wherein the plastic back plate has a top side and a bottom side opposite to each other and a left side and a right side opposite to each other, and the platform and the two overflow tanks extend in a U shape to connect the top side, the left side, and the right side of the plastic back plate.

12. The environment-friendly display module according to claim 5, wherein the metal bracket has a support portion and a bent portion, the bent portion extends from the support portion and forms a groove to accommodate the light bar, and a bottom side of the plastic back plate is connected to the support portion.

13. The environment-friendly display module according to claim 12, wherein the panel component comprises a light guide module and a liquid crystal module, a portion of the light guide module extends into the groove to receive light generated by the light bar, the liquid crystal module is disposed on the light guide module and partially leans against the bent portion, and the light is transmitted to the liquid crystal module through the light guide module.

14. The environment-friendly display module according to claim 13, wherein the support portion comprises a first region and a second region, the second region is connected between the first region and the bent portion, the first region supports a portion of the plastic back plate, and the second region supports a portion of the light guide module.

15. The environment-friendly display module according to claim 14, wherein the support portion further has a plurality of protrusions located in the second region, and each of the protrusions supports the light guide module in at least one of a surface contact manner and a line contact manner.

16. The environment-friendly display module according to claim 13, further comprising a shielding mask covering the outside of the bent portion of the metal bracket, and a plurality of cables and a plurality of circuit board modules extend from a display surface of the liquid crystal module, pass through the bent portion and extend to the support portion, and are located between the metal bracket and the shielding mask.

17. An environment-friendly display device, comprising: the environment-friendly display module according to claim 1; a control module, assembled to the plastic module and electrically connected to the display module; a back cover, assembled to the plastic module and enabling the control module to be covered between the plastic module and the back cover; and a decorative bar, assembled to the plastic module and the back cover and located at a bottom of the plastic module.

18. The environment-friendly display device according to claim 17, wherein the plastic module comprises a plastic back plate and a plastic middle frame assembled to each other, the plastic middle frame surrounds a portion of the plastic back plate, the control module is assembled to the plastic back plate, the back cover is assembled to the plastic middle frame, so that the control module is covered between the plastic back plate and the back cover, and the decorative bar is assembled to the plastic middle frame and the back cover and is located at a bottom side of the plastic back plate.

19. The environment-friendly display device according to claim 18, wherein the display module comprises a metal bracket, a light bar, and a panel component, the metal bracket is assembled to a

bottom side of the plastic back plate, the light bar is disposed on the metal bracket, the panel component is disposed in a region formed by the plastic back plate, the metal bracket, and the plastic middle frame, the control module is electrically connected to the light bar, and the decorative bar covers the metal bracket.

20. The environment-friendly display device according to claim 19, wherein the control module comprises a circuit board component and a metal casing, the circuit board component is accommodated in the metal casing, and the metal casing is assembled to the plastic back plate, so that the circuit board component is covered between the metal casing and the plastic back plate.

21. The environment-friendly display device according to claim 20, further comprising a plurality of conductive fabrics arranged in a closed outline along an opening of the metal casing, wherein the metal casing is attached to the plastic back plate through the conductive fabrics, and part of the conductive fabrics is attached to the metal bracket.

22. The environment-friendly display device according to claim 19, wherein the metal bracket has a support portion and a bent portion, the bent portion extends from the support portion and forms a groove to accommodate the light bar, the bottom side of the plastic back plate is connected to the support portion, the panel component comprises a light guide module and a liquid crystal module, a portion of the light guide module extends into the groove, and the liquid crystal module is disposed on the light guide module and partially leans against the bent portion.

23. The environment-friendly display device according to claim 22, wherein the environment-friendly display module further comprises a shielding mask covering the outside of the bent portion of the metal bracket, a plurality of cables and a plurality of circuit board modules of the liquid crystal module extend from a display surface of the liquid crystal module, pass through the bent portion and extend to the support portion, and are located between the metal bracket and the shielding mask, the decorative bar extends from the bottom side to the display surface of the liquid crystal module, and the liquid crystal module is connected to the bent portion and located between the decorative bar and the bent portion.
