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(71) Applicant: **KABUSHIKI KAISHA KOMATSU SEISAKUSHO**
3-6, Akasaka 2-chome, Minato-ku
Tokyo 107(JP)

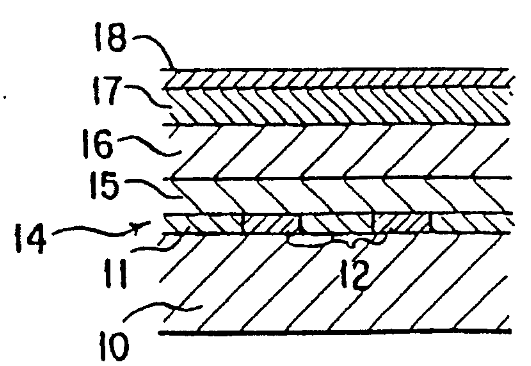
(72) Inventor: **TSURUMAKI, Naoya Techn.Inst. of K.K. Komatsu Se isakusho 1200, Manda**
Hiratsuka-shi Kanagawa-ken 254(JP)

(74) Representative: **Dr. Fuchs, Dr. Luderschmidt Dipl.-Phys. Seids, Dr. Mehler Patentanwälte**
Abraham-Lincoln-Strasse 7, Postfach 4660
W-6200 Wiesbaden(DE)

(54) THIN-FILM ELECTROLUMINESCENT ELEMENT AND METHOD OF MANUFACTURING THE SAME.

(57) Thin-film electroluminescent element preventing the formation by electric breakdown of defective portions where display is impossible, and a method of manufacturing the same. The thin-film EL element is of a double insulating structure and of a type of matrix driving. Transparent electrodes (13) are formed in a transparent and flat insulating film (11) on an insulating and light-transmiting substrate (10). The manufacturing method comprises a step of forming the insulating metal oxide film (11) on the light-transmitting substrate (10), a step of selectively forming metal layers (12) on the surface of the metal oxide film, and a step of forming the transparent electrodes (13) by diffusing these metal layers into the metal oxide film.

Figur 5



EP 0 450 077 A1

Technical Field of the Invention

The present invention relates to both a thin film EL element to be used in the display of an instruments panel to be mounted in a vehicle or other various apparatus and a fabrication process of the same.

Background Technology of the Invention

A thin film EL element of the prior art in the case of a matrix drive is shown in section in Fig. 1.

This thin film EL element is formed over a transparent substrate 1 with transparent electrodes 2 and above the substrate 1 with first electrically insulating film 3, an EL layer 4, a second electrically insulating film 5 and a metal back electrode 6 in the recited order.

The thin film EL element thus constructed emits a light when a voltage no less than a luminescence threshold voltage is applied between the metal back electrode 6 and the transparent electrodes 2. At this time, the electric field established is concentrated at the edge portions 7 of the transparent electrodes 2 to cause a dielectric breakdown. Thus, there arises a trouble that the display becomes impossible at those portions.

Summary of the Invention

The present invention has been conceived in view of the circumstances thus far described and has an object to provide a thin film EL element cleared of the portions such as the edge portions of the transparent electrodes, in which the electric field might otherwise be concentrated, and accordingly the display-impossible portions due to the dielectric breakdown.

Another object of the present invention is to provide a process for fabricating a thin film EL element, which is enabled to form a flattened transparent electrode layer having both an electrically insulating metal oxide film formed with transparent electrodes and an electric insulator.

In order to achieve the above-specified first object, according to a first mode of the present invention, there is provided a thin film EL element having a double insulation structure for a matrix drive, which element is characterized in that transparent electrodes over an electrically insulating transparent substrate is formed in a transparent, flat electrically insulating film.

In order to achieve the above-specified second object, according to a second mode of the present invention, there is provided a process for fabricating a thin film EL element having a double insulating structure for a matrix drive, comprising: the step of an electrically insulating metal oxide film over an electrically insulating transparent substrate; the step of forming metal layers selectively over the surface of said metal oxide film; and the step of forming transparent electrodes by diffusing said metal layers into said insulating metal oxide film.

Since the transparent electrodes are formed in the transparent, flat insulating film, according to the aforementioned thin film EL element of the first mode, the edge portions of the transparent electrodes of the prior art, in which the electric field is concentrated, are eliminated to eliminate the display-impossible portions due to the dielectric breakdown.

According to the aforementioned fabrication process of the second mode, moreover, the transparent electrodes can be formed in the insulating metal oxide film, the remaining portions of which can be formed with the flat, transparent electrode layer acting as the insulator.

The aforementioned and other objects, modes and advantages of the present invention will become apparent to those skilled in the relevant art in view of the following description which is to be made in connection with a preferable, specific embodiment conforming to the principle of the present invention and with reference to the accompanying drawing.

Brief Description of the Drawing

Fig. 1 is a schematic section showing the structure of the thin film EL element of the prior art;
Fig. 2 is an explanatory view for explaining the formation of an electrically insulating metal oxide film of a specific embodiment of the present invention;
Fig. 3 is an explanatory view for explaining the selective formation of metal layers of the specific embodiment of the present invention;
Fig. 4 is an explanatory view showing a metal diffusion in the specific embodiment of the present invention; and
Fig. 5 is a schematic section showing the structure of a thin film EL element according to the specific embodiment of the present invention.

Detailed Description of the Preferred Embodiment

The specific embodiment of the present invention will be described in detail in the following with reference to the accompanying drawing (i.e., Figs. 2 to 5).

First of all for fabricating the thin film EL element according to the present invention, as shown in Fig. 2, an electrically insulating transparent substrate 10 is formed thereover with an electrically insulating metal oxide film 11 of ZnO or the like by the sputtering method, the electron beam vapor deposition or the like.

As shown in Fig. 3, metal layers 12 are formed only at portions for the electrodes by the vapor deposition of a metal such as Al using a mask.

The step of thus forming the metal layers 12 selectively may be exemplified by vapor-depositing the metal at first all over surface and then by patterning the deposited metal by the photolithography. Alternatively, the metal may be vapor-deposited over a patterned photo resist, followed by the lift-off method of peeling the resist.

Next, as shown in Fig. 4, the aforementioned transparent substrate 10 is subjected to a heat treatment (e.g., annealed) in the vacuum to diffuse the metal of the aforementioned metal layers 12 into the electrically insulating metal oxide film 11 thereby form transparent electrodes 13.

Next, as shown in Fig. 5, a transparent electrode layer 14 composed of the electrically insulating metal oxide film 11 and the transparent electrodes 13 is formed thereabove with a first electrically insulating film 15, an electroluminescence layer 16, a second electrically insulating film 17 and a back metal electrode 18 in the recited order to fabricate the thin EL element.

In the formation of the aforementioned transparent electrodes 13, it is known that the metal oxide, i.e., ZnO is an electric insulator having a band gap of about 3.2 eV and a specific resistance of 10^8 to 10^{11} Ω cm but is turned, if doped (or added) with Al, into a transparent conductor having its specific resistance dropped to 10^{-4} Ω cm equal to that of ITO.

By the aforementioned fabrication process of the thin film EL element, therefore, the transparent electrode layer 14 thus formed is flat and retain the conductivity only at the portions of the transparent electrodes 13 but is electrically insulating at the other portions.

This eliminates the portions such as the edge portions 7 of the transparent electrodes 2 of the prior art, in which the electric field is concentrated, to eliminate the display-impossible portions due to the dielectric breakdown.

Example 1:

A glass substrate of 50 x 50 mm^2 was formed with a film of ZnO having a thickness of 2,000 Å (at the temperature of 500 °C at the glass substrate at this time) by the rf magnetron sputtering method. The ZnO film was then vapor-evaporated thereover with Al to have a thickness of about 100 Å by the electron beam deposition using a metal mask formed of sixteen rows of slits having a width of 1 mm and a length of 50 mm at a pitch of 1.8 mm.

Next, the intermediate was subjected to the heat treatment in the vacuum at 500 °C for thirty minutes.

The intermediate was formed thereover with the first electrically insulating film of Ta_2O_5 having a thickness of 5,000 Å by the rf magnetron sputtering method and then with the electroluminescence layer of Zns:Mn (wherein Ms is 0.5 at %) having a thickness of 6,000 Å.

The second electrically insulating film was similar to the first electrically insulating film. At last, the back metal electrode was formed with Al to have a thickness of 3,000 Å by the electron beam deposition using a metal mask formed of sixteen rows of slits having a width of 1 mm and a length of 50 mm at a pitch of 1.8 mm and positioned at a right angle with respect to the metal mask of the aforementioned case of the Al deposition.

Claims

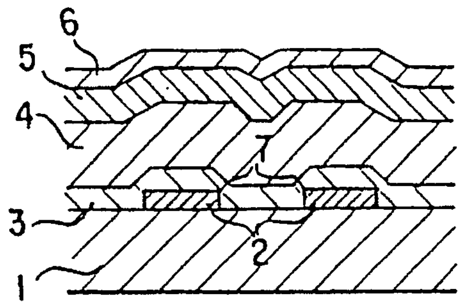
1. A thin film EL element having a double insulation structure for a matrix drive, which element is characterized in that transparent electrodes over an electrically insulating transparent substrate is formed in a transparent, flat electrically insulating film.

2. A process for fabricating a thin film EL element having a double insulating structure for a matrix drive, comprising: the step of an electrically insulating metal oxide film over an electrically insulating transparent substrate; the step of forming metal layers selectively over the surface of said metal oxide film; and the step of forming transparent electrodes by diffusing said metal layers into said insulating metal oxide film.

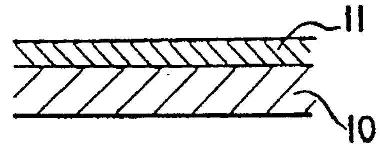
3. A thin film EL element fabricating process as set forth in Claim 2, characterized in that said insulating metal oxide film is made of ZnO.

4. A thin film EL element fabricating process as set forth in Claim 2, characterized in that said metal layer is made of Al.

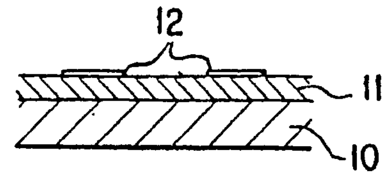
Figur 1



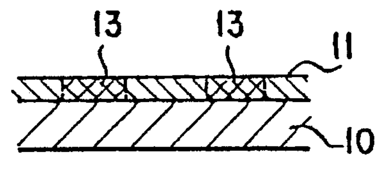
Figur 2



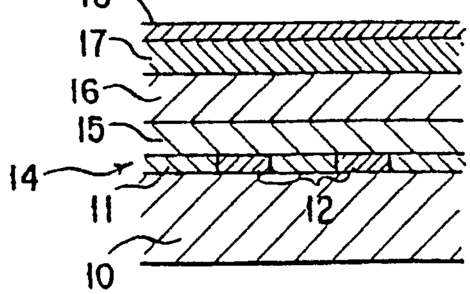
Figur 3



Figur 4



Figur 5



INTERNATIONAL SEARCH REPORT

International Application No PCT/JP89/01266

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int. Cl^5 H05B33/28, H05B33/10

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC	H05B33/00 - 33/28

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

Jitsuyo Shinan Koho	1967 - 1989
Kokai Jitsuyo Shinan Koho	1971 - 1989

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	JP, A, 61-151996 (Hitachi, Ltd.), 10 July 1986 (10. 07. 86), (Family: none)	1
X	JP, A, 61-131396 (Hoya Corporation), 19 June 1986 (19. 06. 86), (Family: none)	1
X	JP, U, 61-146894 (Nissan Motor Co., Ltd.), 10 September 1986 (10. 09. 86), (Family: none)	1
Y	JP, A, 48-3088 (Hitachi, Ltd.), 16 January 1973 (16. 01. 73), (Family: none)	2, 3, 4
Y	JP, A, 47-16990 (Hughes Aircraft Co.), 5 September 1972 (05. 09. 72) & US, A, 4088799 & DE, B, 2202585	2, 3, 4
Y	JP, A, 58-68960 (Siemens A.G.), 25 April 1983 (25. 04. 83), & EP, B, 75874 & US, A, 4466839	2, 3, 4

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
March 2, 1990 (02. 03. 90)	March 19, 1990 (19. 03. 90)
International Searching Authority	**Signature of Authorized Officer**
Japanese Patent Office	