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(71) Applicant: HITACHI, LTD.
6, Kanda Surugadai 4-chome Chiyoda-ku
Tokyo 100(JP)

(72) Inventor: Inoue, Eisuke
460, Shimonagayoshi
Mobara-shi Chiba(JP)

(72) Inventor: Nonaka, Yasuhiko
38-2, Midori-cho
Mobara-shi Chiba(JP)

(72) Inventor: Yamamoto, Masanao
1502, Mobara
Mobara-shi Chiba(JP)

(74) Representative: Hauck, Hans, Dipl.Ing. Patentanwälte
Dipl.-Ing. H. Hauck et al,
Dipl.-Phys. W. Schmitz Dipl.-Ing. E. Graalfs Dipl.-Ing. W. Wehnert Dr.-Ing. W. Döring
Mozartstrasse 23 D-8000 München 2(DE)

## (54) Image pickup tube target.

(57) An image pickup tube target includes a Se-As-Te photoconductive layer whose arsenic concentration changes in a direction of thickness of the Se-As-Te photoconductive layer, a carrier extraction layer having a high arsenic concentration and being contiguous to the Se-As-Te photoconductive layer, a capacitive layer having a low arsenic concentration and being contiguous to the carrier extraction layer, a doped layer obtained by doping $In_2O_3$, $MoO_2$ or a mixture thereof in an interface between the carrier extraction layer and the capacitive layer.

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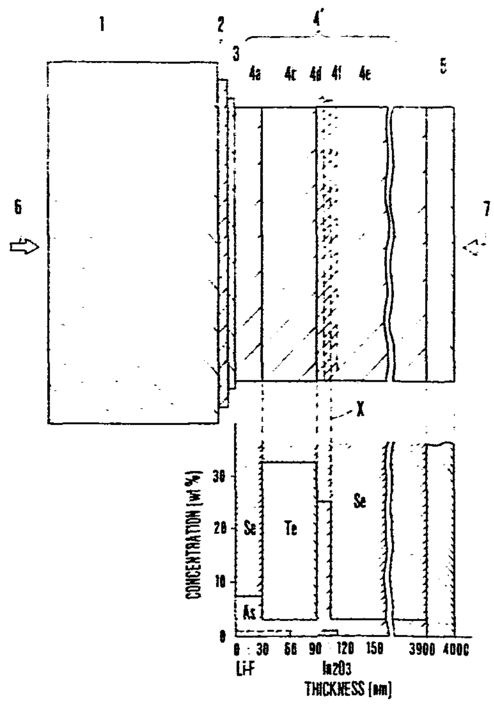


1
2
3
4'
4a
4c
4d
4f
4e
5
6
7
X
Se
Te
Se
As
CONCENTRATION (wt %)
0
10
20
30
0 30 60 90 120 150 3900 4000
LiF
In2O3
THICKNESS (nm)


FIG.2

0114652

Specification

Title of the Invention

Image Pickup Tube Target

Background of the Invention

I. Field of the Invention

The present invention relates to an image pickup tube target and, more particularly, to a structure of a Se-As-Te type chalcogen photoconductive film (Saticon film) with improved sticking characteristics.

II. Description of the Prior Art

Fig. 1 shows a section of a main part of a conventional image pickup tube target and a concentration distribution of selenium, arsenic and tellurium as major constituents of a photoconductive film.

Referring to Fig. 1, a transparent conductive film 2 containing $SnO_2$ or $In_2O_3$ as a major constitutent is formed on the rear major surface of a disc-like translucent glass substrate 1. A very thin N-type transparent $CeO_2$ conductive film 3 serving as a blocking layer is formed on the rear major surface of the transparent conductive film 2. A P-type photoconductive film 4 comprising a P-type Se-As-Te amorphous semiconductor film is formed on the rear major surface of the N-type transparent conductive film 3. A P-type $Sb_2S_3$ photoconductive film 5 serving as a beam landing layer is formed on the rear major surface of the P-type photoconductive film 4. The P-type photoconductive film 4 consists of first, second and third P-type photoconductive layers 4a, 4b and 4c. The first P-type photoconductive layer 4a comprises a P-type Se-As amorphous semiconductor film having an Se concentration of 97 to 88 wt% and an As concentration of 3 to 12 wt% and is formed on the rear major surface of the N-type transparent conductive film 3 to have a thickness of 30 to 60 nm. The second P-type photoconductive layer 4b comprises a P-type Se-As-Te amorphous semiconductor film having an Se concentration of about 67 wt%, an As concentration of 3 wt%, and a Te concentration of about 30 wt% and is formed on the rear major surface of the first P-type photoconductive layer 4a to have a thickness of about 60 nm. The third P-type photoconductive layer 4c is formed on the rear major surface of the second P-type photoconductive layer 4b such that a total thickness of the multilayer film 4 is set to be about 3900 nm, for example. The third P-type photoconductive layer 4c comprises a P-type Se-As amorphous semiconductor film wherein in the Se-As concentration distribution, the As concentration continuously changes from 20 to 30 wt% to 3 ± 2 wt% over a thickness of 45 ± 20 nm which starts from the interface between the second and third P-type photoconductive layers 4b and 4c. The 3 ± 2 wt% As concentration remains unchanged as the thickness increases. The P-type photocoductive film 5 is formed on the rear major surface of the multilayer film 4. A light beam 6 is incident on the front major surface of the glass substrate 1, and a scanning electron beam 7 is supplied to the P-type photoconductive film 5.

In the image pickup tube target having the structure described above, the gradient As concentration layer as part of the third P-type photoconductive layer 4c serves as a carrier extraction layer for effectively and stably extracting carriers generated in the Te layer of the second P-type photoconductive film 4b. The gradient As concentration layer also serves to prevent the Te layer from being diffused, thereby preventing degradation of the voltage-photocurrent characteristic (V-I characteristic) forming part of evaluation criterion. The uniform 3 ± 2 wt% As concentration layer contiguous to the gradient As concentration layer serves as a capacitive layer for storage of the carriers. The P-type photoconductive layer 4c including the gradient As concentration layer and the uniform As concentration layer is the most important layer to determine quality of the electrical characteristics of the target in use.

However, when a highly luminous object or a still object is photographed with an image pickup tube having the above-mentioned target, a so-called sticking phenomenon occurs wherein a previous image sticks to the present image. The occurrence of this phenomenon is mainly dependent on the P-type photoconductive film 4.

Especially, when a Saticon film is used, the sticking phenomenon largely depends on the content of highly concentrated arsenic in the third P-type photoconductive layer 4c. With the content of arsenic decreased, the sticking can be suppressed but sufficient extraction of the carriers from the Te layer cannot be sustained. As a result, a practically sufficient signal current cannot be obtained.

Summary of the Invention

It is, therefore, an object of the present invention to provide an image pickup tube target capable of suppressing the sticking phenomenon by providing an indium-doped layer containing indium oxide, substantially free from the sticking phenomenon, to a slight extent that a decrease in carrier extraction effect due to a decrease in arsenic content of the high arsenic concentration layer can be compensated for.

In order to achieve the above object of the present invention, there is provided an image pickup tube target comprising: a translucent glass substrate; a first transparent conductive film formed on a rear major surface of said translucent glass substrate; a second transparent conductive film serving as a blocking layer and formed on a rear major surface of said first transparent conductive film; a multilayer photocoductive film which has first to fourth amorphous semiconductor layers containing selenium, arsenic and tellurium as major constituents, which is formed on a rear major surface of said second transparent conductive film to have a predetermined thickness and which has an arsenic concentration distribution changing in a direction of thickness of said multilayer photoconductive film; a single photoconductive film formed on a rear major surface of said fourth amorphous semiconductor layer of said multilayer photoconductive film; and a layer doped with a dopant having negative space charges in selenium and formed across an interface between said thrid and fourth amorphous semiconductor layers of said multilayer photoconductive film.

Brief Description of the Drawings

Fig. 1 is a diagram for explaining a conventional image pickup tube target;

Fig. 2 is a diagram for explaining an image pickup tube target according to an embodiment of the present invention;

Fig. 3 is a graphical representation useful in explaining effects of the present invention;

Figs. 4a to 4c are diagrams showing various positions of the indium-doped layer; and

Fig. 5 is a diagram showing an actual contour of the interface between the third and fourth amorphous semiconductor layers.

Detailed Description of the Preferred Embodiments

Fig. 2 shows a section of a main part of an image pickup tube target according to an embodiment of the present invention, and a diagram of a Se-As-Te concentration distribution. In Figs. 1 and 2, the same reference numerals are used to denote the same parts, a detailed description of which will be omitted.

Referring to Fig. 2, a third P-type photoconductive layer 4d as a carrier extraction layer is formed on the rear major surface of a second P-type photoconductive layer 4b as a carrier generating layer to have a thickness of 12 ± 6 nm. The layer 4d comprises a P-type Se-As amorphous semiconductor film having a concentration distribution such that the Se concentration is 75 ± 5 wt% and the As concentration is 25 ± 5 wt%. A fourth P-type photoconductive layer 4e serving as a capacitive layer is formed on the rear major surface of the third P-type photoconductive layer 4d to have a thickness such that a multilayer film 4' has a total thickness of, for example, about 3900 nm. The fourth P-type photoconductive layer 4e comprises a P-type Se-As amorphous semiconductor film having a concentration such that the Se concentration is 97 ± 2 wt% and the As concentration is 3 ± 2 wt%. $In_2O_3$ having negative space charges in selenium is doped to a thickness of 3 to 30 nm at a concentration of 100 to 3,000 wtppm across an interface between the third and fourth P-type photoconductive layers 4d and 4e, so that an $In_2O_3$-doped layer 4f is formed not to contact the Te layer of the second P-type photoconductive layer 4b.

Although the layer 4f is illustrated as doped with $In_2O_3$, other dopants such as $MoO_2$ or a mixture of $In_2O_3$ and $MoO_2$ which have negative space charges in selenium may also be used.

In the P-type multilayer film 4' having the structure described above, the arsenic content (concentration x thickness) in the third P-type photoconductive layer 4d as the carrier extraction layer is decreased to 1/3 to 1/6 of that of the conventional image pickup tube target. In addition, the doped layer 4f of $In_2O_3$, $MoO_2$ or mixture thereof which has negative space charges in selenium and which has carrier extraction capability is formed across the interface between the third and fourth P-type photoconductive layers 4d and 4e, so that the carrier extraction efficiency is greatly improved and the sticking phenomenon can be greatly decreased. In this case, when the arsenic content of the carrier extracton layer is decreased to about 1/6 or lower, the effect for preventing tellurium from being diffused from the second P-type photoconductive layer 4b is impaired. Therefore, the arsenic content in a rectangular concentration distribution cannot be decreased to about 1/6 or lower.

Fig. 3 shows the relation between the position of the indium-doped layer 4f and the sticking contrast for various $In_2O_3$ doping contents (wtppm·nm) as defined by concentration y (wtppm) x thickness x (nm). Curves 1 to 4 correspond to doping contents of 90000 wtppm·nm (3000 wtppm x 30 nm), 15000 wtppm·nm (1000 wtppm x 15 nm), 8000 wtppm·nm (750 wtppm x 12 nm) and 300 wtppm·nm (100 wtppm x 3 nm), respectively. Points P1, P2 and P3 correspond to positions of the indium-doped layer as shown in Figs. 4a, 4b and 4c, respectively. It will then be appreciated that when the indium-doped layer is formed across the interface X, preferably, substantially centered to the interface X, all the characteristic curves 1 to 4 representative of 100 to 3000 wtppm $In_2O_3$ doping concentrations and 3 to 30 nm indium-doped layer thicknesses fall in an allowable sticking contrast range as hatched.

In the foregoing embodiment, the $In_2O_3$ layer is formed in a thickness region having as a center the interface or boundary X where the arsenic content (25 ± 5 wt%) of the third P-type photoconductive layer 4d is abruptly decreased to the arsenic content (3 ± 2 wt%) of the fourth P-type photoconductive layer 4e. In effect, however, the arsenic content gradually decreases as shown at solid line or dotted line in Fig. 5. In this case, the $In_2O_3$ layer may be formed in a thickness region having as a center a point where the arsenic concentration of the third P-type photoconductive layer 4d is decreased to 10% of an arsenic concentration difference between the third and fourth P-type photoconductive layers 4d and 4e. This point is also defined as interface or boundary X in this application. Further, the total thickness of P-type photoconductive layer 4' is not limited to 3900 nm and the effects of the present invention can be attained irrespective of the total thickness. For example, the total thickness may be 5900 nm with the photoconductive layer 5 ending at 6000 nm.

In a modification of the embodiment described above, $In_2O_3$, $MoO_2$ or a mixture thereof is doped in a highlight sticking prevention Saticon film (Japanese Patent Application No. 55-157084) doped with Li-F across an interface between the first and second P-type photoconductive layers 4a and 4b as shown at dotted line in Fig. 2, to form a doped layer 4f. In this modification, the sticking phenomenon can be prevented in the same manner as in the above embodiment. In addition, the sticking phenomenon which results from photographing of a highly luminous object can also be suppressed

As has been described, according to the image pickup tube target of the present invention, the sticking phenomenon due to highly luminous incident light can be greatly decreased to obtain a high-quality image.

The present invention is not limited to the particular embodiments described above, and various changes and modifications may be made within the spirit and scope of the present invention.

What is Claimed is:

1. An image pickup tube target comprising:

a translucent substrate;

a first transparent conductive film formed on a rear major surface of said translucent substrate;

a second transparent conductive film serving as a blocking layer and formed on a rear major surface of said first transparent conductive film;

a multilayer photoconductive film which has first to fourth amorphous semiconductor layers containing selenium, arsenic and tellurium as major constituents, which is formed on a rear major surface of said second transparent conductive film to have a predetermined thickness and which has an arsenic concentration distribution changing in a direction of thickness of said multilayer photoconductive film;

a single photoconductive film formed on a rear major surface of said fourth amorphous semiconductor layer of said multilayer photoconductive film; and

a layer doped with a dopant having negative space charges in selenium and formed across an interface between said third and fourth amorphous semiconductor layers of said multilayer photoconductive film.

2. An image pickup tube target according to claim 1 wherein the dopant is $In_2O_3$.

3. An image pickup tube target according to claim 1 wherein dopant is $MoO_2$.

4. An image pickup tube target according to claim 1 wherein dopant is a mixture of $In_2O_3$ and $MoO_2$.

5. An image pickup tube target according to claim 1, wherein said interface is a boundary where the arsenic concentration is abruptly decreased.

6. An image pickup tube target according to claim 1, wherein said interface is a boundary where the arsenic concentration is decreased to about 10% of an arsenic concentration difference between said third and fourth amorphous semiconductor layers when the arsenic concentration gradually changes therebetween.

7. An image pickup tube target according to claim 1, 5 or 6, wherein said doped layer is centered to said interface.

8. An image pickup tube target according to claim 7, wherein said doped layer is formed such that indium oxide is doped to a concentration of 100 to 3,000 wtppm to a thickness falling within a range of 3 to 30 nm.

9. An image pickup tube target according to claim 1

further comprising an Li-F layer formed across an interface between said first and second P-type photoconductive layers.

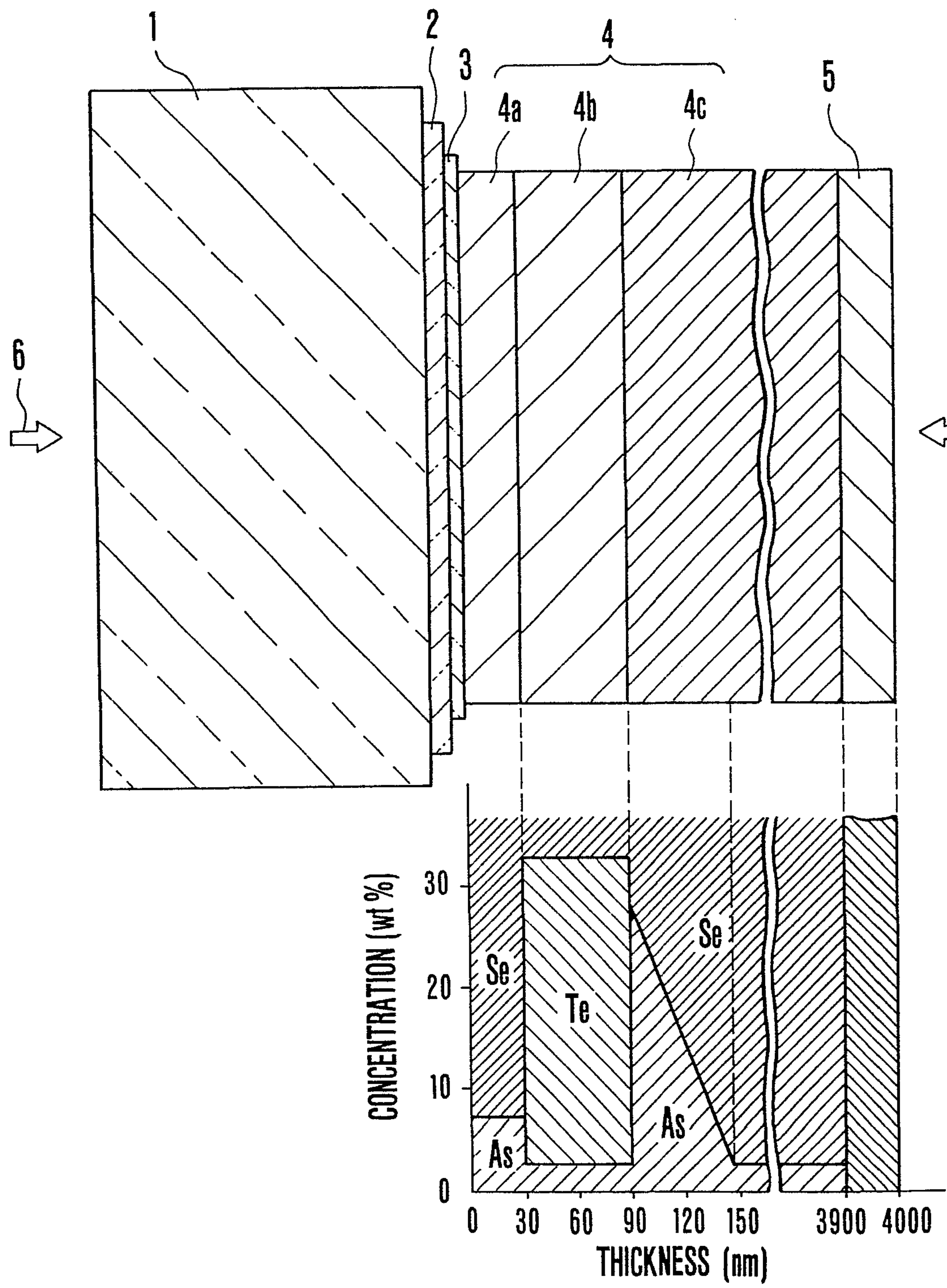
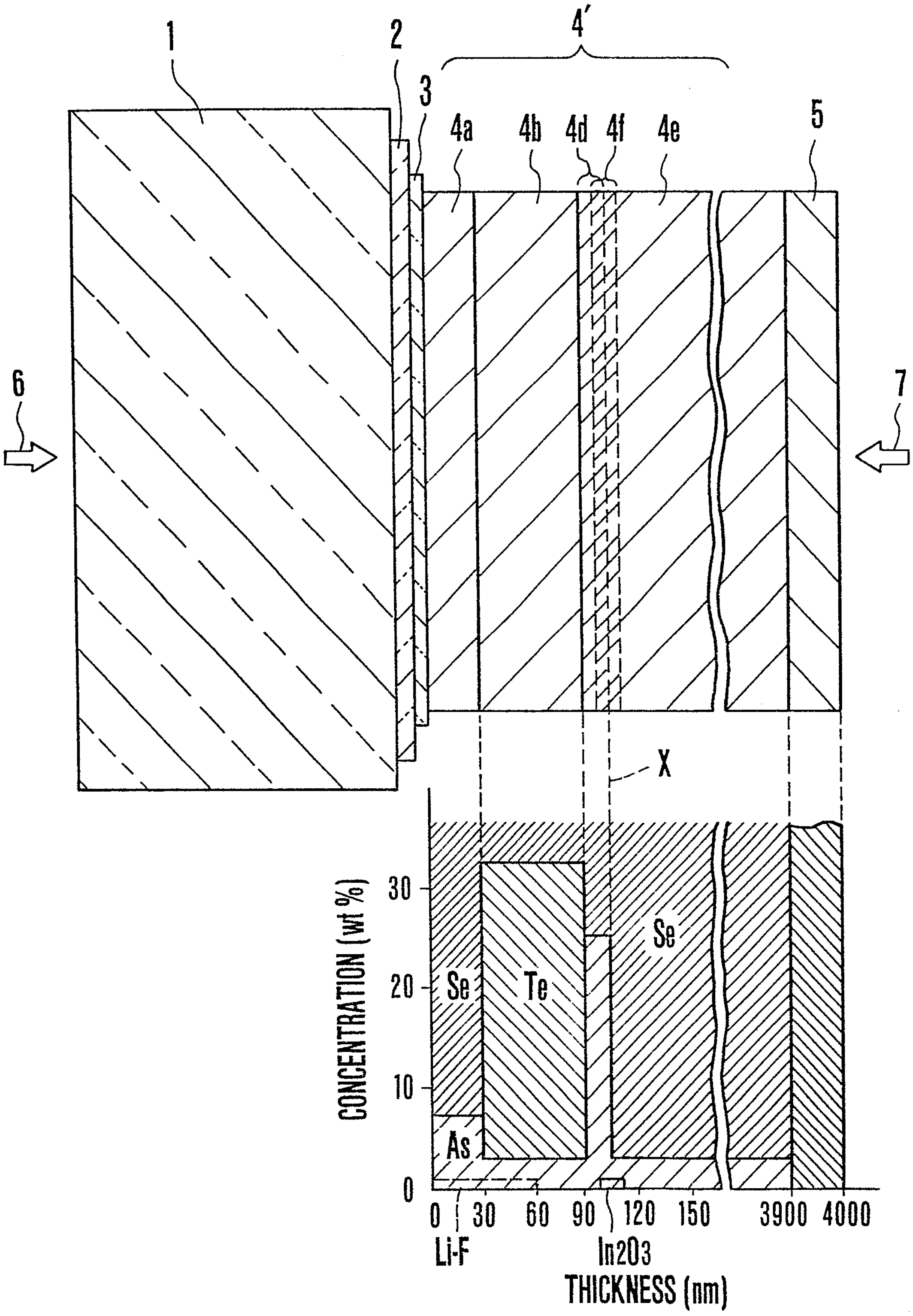



FIG.1
PRIOR ART



1
2
3
4'
4a
4b
4d
4f
4e
5
6
7
X
CONCENTRATION (wt %)
30
20
10
0
Se
Te
Se
As
0
30
60
90
120
150
3900
4000
Li-F
In2O3
THICKNESS (nm)


FIG.2

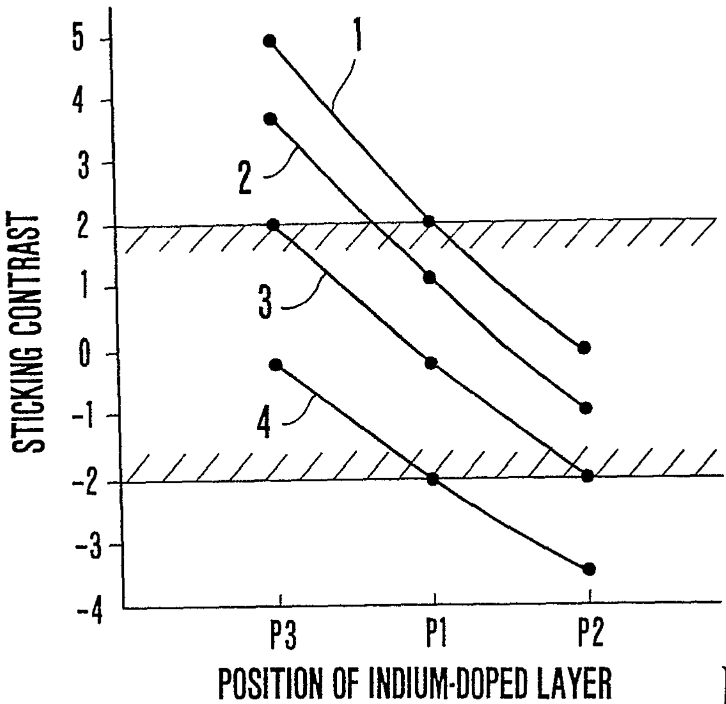



FIG.3

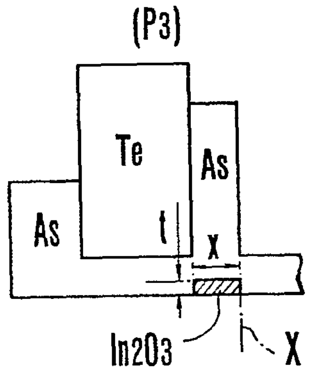



FIG.4c

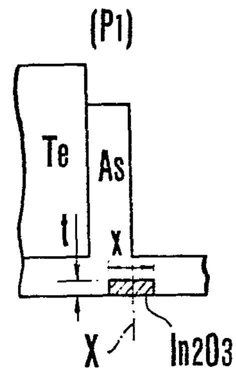



FIG.4a

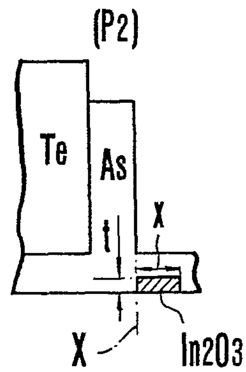



FIG.4b

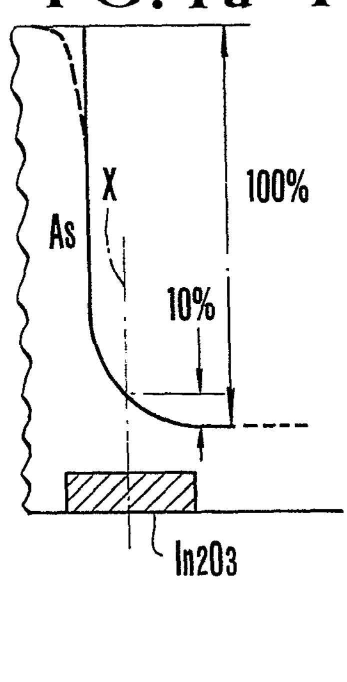



FIG.5