gives rise to an increased contact resistance causing an imperfection of the carrier collection/injection property at organic/cathode interface.

Therefore, in view of the above, there exists a need for an electrically conducting structure for a light transmissible device and a method of forming an electrically conducting structure for a light transmissible device that seek to address at least one of the above problems.

SUMMARY

In accordance with a first aspect of the present invention, there is provided an electrically conducting structure for a light transmissible device, the structure comprising, a first transparent conducting material layer formed over underlying functional material using first process conditions, the first process conditions comprise a first deposition power and a first deposition temperature; at least one other transparent conducting material layer formed directly on the first transparent conducting material layer, said at least one other transparent conducting material layer being formed using second process conditions that are different from the first process conditions, the second process conditions may comprise a second deposition power and a second deposition temperature; wherein the first process conditions may be chosen such that adverse effects to the underlying functional material are reduced during formation of the first transparent conducting material layer, as compared to applying the second process conditions directly to the underlying functional material; ~~and~~ wherein the first transparent conducting material layer functions as a buffer layer to reduce adverse effects for the light transmissible device during formation of said at least one other transparent conducting material layer; wherein the first transparent conducting material layer is an oxygen deficient material layer having limited stability in conductivity in air formed in the presence of a gas mixture comprising oxygen, argon and hydrogen; and wherein the at least one other transparent conducting material layer formed on the first transparent conducting material layer possesses stable conductivity in air for enhancing the conductivity of the electrically conducting structure.

The ~~first process conditions may comprise a~~ first deposition power and thea first deposition temperature~~; the second process conditions may comprise a second deposition power and a second deposition temperature; wherein the first deposition power, the first deposition temperature and the second deposition temperature~~ may each be chosen such that adverse temperature and deposition-power induced effects for the light transmissible device are reduced; and wherein the second deposition power may be chosen to provide a desired film quality of said at least one other transparent conducting material layer.

The structure may further comprise one or more metal layers wherein the first transparent conducting material layer is formed over the metal layers.

Said at least one other transparent conducting material layer formed on the first transparent conducting material layer together may function as an index matching structure for enhancing light output of the device.

Said at least one other transparent conducting material formed on the first transparent conducting material layer together may function to improve current spreading of the device.

The first transparent conducting material layer and said at least one other transparent conducting material layer may be formed using a physical deposition technique, a chemical deposition technique or both.

The first transparent conducting material layer may be formed using direct current (DC) magnetron sputtering.

The first deposition power may be about 10W power.

Said at least one other transparent conducting material layer may be formed using radio frequency (RF) magnetron sputtering.

The second deposition power may be about 100W power.

A substrate temperature during deposition of the first transparent conducting material layer may be about 60°C or less.

The substrate temperature during deposition of said at least one other transparent conducting material layer may be about 60°C or less.

The first transparent conducting material layer and said at least one other transparent conducting material layer may each comprise one or more materials selected from a group consisting of SnO_2, Ga-In-Sn-O (GITO), Zn-In-Sn-O (ZITO), Ga-In-O (GIO), Zn-In-O (ZIO), In-Sn-O (ITO) ~~and other transparent conducting materials~~.

The first transparent conducting material layer and said at least one other transparent conducting material layer may comprise the same transparent conducting material.

In accordance with a second aspect of the present invention, there is provided a method of forming an electrically conducting structure for a light transmissible device, the method comprising, forming a first transparent conducting material layer over underlying functional material using first process conditions, the first process conditions comprise a first deposition power and a first deposition temperature; forming at least one other transparent conducting material layer directly on the first transparent conducting material layer using second process conditions that are different from the first process conditions, the second process conditions comprise a second deposition power and a second deposition temperature; wherein the first process conditions are chosen such that adverse effects to the underlying functional material are reduced during formation of the first transparent conducting material layer, as compared to applying the second process conditions directly to the underlying functional material; ~~and~~ wherein the first transparent conducting material layer functions as a buffer layer to reduce adverse effects for the light transmissible device during formation of said at least one other transparent conducting material layer; wherein the first transparent conducting material layer is an oxygen deficient material layer having limited stability in conductivity in air formed in the presence of a gas mixture comprising oxygen, argon and hydrogen; and wherein the at least one other transparent conducting material layer formed on the first transparent conducting material layer possesses stable conductivity in air for enhancing the conductivity of the electrically conducting structure.

The ~~first process conditions may comprise a first deposition power and a first deposition temperature; the second process conditions may comprise a second deposition power and a second deposition temperature; and the~~ method may ~~further~~ comprise choosing each of the first deposition power, the first deposition temperature and the second deposition temperature such that adverse temperature and deposition-power induced effects for the light transmissible device are reduced; and choosing the second deposition power to provide a desired film quality of said at least one other transparent conducting material layer.

The method may further comprise providing one or more metal layers and forming the first transparent conducting material layer over the metal layers.

Said at least one other transparent conducting material layer formed on the first transparent conducting material layer together may function as an index matching structure for enhancing light output of the device.

Said at least one other transparent conducting material layer formed on the first transparent conducting material layer together may function to improve current spreading of the device.

The first transparent conducting material layer and said at least one other transparent conducting material layer may be formed using a physical deposition technique, a chemical deposition technique or both.

The first transparent conducting material layer may be formed using direct current (DC) magnetron sputtering.

The first deposition power may be about 10W power.

Said at least one other transparent conducting material layer may be formed using radio frequency (RF) magnetron sputtering.

The second deposition power may be about 100W power.

A substrate temperature during deposition of the first transparent conducting material layer may be about 60°C or less.

A substrate temperature during deposition of said at least one other transparent conducting material layer may be about 60°C or less.

The first transparent conducting material layer and said at least one other transparent conducting material layer may each comprise one or more materials selected from a group consisting of SnO_2, Ga-In-Sn-O (GITO), Zn-In-Sn-O (ZITO), Ga-In-O (GIO), Zn-In-O (ZIO), In-Sn-O (ITO)~~ and other transparent conducting materials.~~.

The first transparent conducting material layer and said at least one other transparent conducting material layer may comprise the same transparent conducting material.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will be better understood and readily apparent to one of ordinary skill in the art from the following written description, by way of example only, and in conjunction with the drawings, in which:

Figure 1 is a schematic diagram illustrating a light transmissible device in an example embodiment.