CLAIMS

[Claim 1]

A field-effect transistor comprising:

a source electrode and a drain electrode, and

an active layer formed of an oxide semiconductor,

wherein the source electrode and the drain electrode each include a metal region formed of one or more metals and an oxide region formed of one or more metal oxides including at least one of the one or more metals, and

wherein a part of the oxide region in each of the source electrode and the drain electrode is in contact with the active layer, and rest of the oxide region is in contact with one or more components other than the active layer,

wherein oxygen concentration in a region of the oxide region in each of the source electrode and the drain electrode decreases toward the metal region, the region of the oxide region in each of the source electrode and the drain electrode being in contact with the active layer,

wherein the one or more components are at least one selected from a gate insulating layer, a substrate, and an interlayer insulating layer.

[Claim 2]

The field-effect transistor according to claim 1,

wherein at least one of the one or more metals is a simple substance of a transition metal or an alloy thereof.

[Claim 3]

The field-effect transistor according to claim 1 or 2,

wherein the at least one of the one or more metals includes at least one selected from the group consisting of Ti, V, Nb, Ta, Mo, and W.

[Claim 4]

The field-effect transistor according to any one of claims 1 to 3,

wherein the source electrode and the drain electrode each have a stacked structure of a first layer and a second layer, the first layer including the metal region and the oxide region and the second layer being formed of a metal, wherein the second layer is a different layer from the metal region of the first layer.

[Claim 5]

The field-effect transistor according to claim 1,

wherein the one or more metal oxides includes a transition metal having a positive valence and a substitutional dopant having a positive valence larger than the positive valence of the transition metal, and

wherein the metal includes an element of the transition metal and an element serving as a dopant with respect to the one or more metal oxides.

[Claim 6]

The field-effect transistor according to claim 5,

wherein the element of the transition metal includes at least one selected from the group consisting of Ti, V, Nb, Ta, Mo, and W.

[Claim 7]

The field-effect transistor according to claim 5 or 6,

wherein the element serving as a dopant with respect to the oxides includes at least one selected from the group consisting of V, Nb, Ta, Cr, Mo, W, Mn, and Re.

[Claim 8]

The field-effect transistor according to any one of claims 1 to 7, wherein the oxide semiconductor includes at least one selected from the group consisting of In, Zn, Sn, and Ti.

[Claim 9]

The field-effect transistor according to claim 8, wherein the oxide semiconductor includes at least one of alkaline earth elements.

[Claim 10]

The field-effect transistor according to claim 8, wherein the oxide semiconductor includes at least one of rare earth elements.

[Claim 11]

The field-effect transistor according to claim 8, wherein the oxide semiconductor is an n-type oxide semiconductor and undergoes a substitutional doping with at least one dopant selected from the group consisting of a bivalent cation, a trivalent cation, a tetravalent cation, a pentavalent cation, a hexavalent cation, a heptavalent cation, and an octavalent cation, and

wherein a valence of the dopant is larger than a valence of a metal ion constituting the oxide semiconductor, provided that the dopant is excluded

from the metal ion.

[Claim 12]

A method for producing the field-effect transistor according to any one of claims 1 to 11, the method comprising

forming the source electrode, the drain electrode, and the active layer so that a part of the oxide region in each of the source electrode and the drain electrode is in contact with the active layer.

[Claim 13]

The method for producing the field-effect transistor according to claim 12, wherein the forming the source electrode, the drain electrode, and the active layer includes:

a treatment of oxidizing a surface of a metal layer to form the source electrode and the drain electrode each having the metal region and the oxide region; and

a treatment of forming the active layer so as to be in contact with the part of the oxide region in each of the source electrode formed and the drain electrode formed, and

wherein oxygen concentration in a region of the oxide region in each of the source electrode and the drain electrode decreases toward the metal region, the region of the oxide region in each of the source electrode and the drain electrode being in contact with the active layer.

[Claim 14]

The method for producing the field-effect transistor according to claim 12, wherein the forming the source electrode, the drain electrode, and the

active layer includes:

a treatment of forming the active layer; and

a treatment of forming the oxide region so that the part of the oxide region is in contact with the active layer formed and further forming the metal region on the oxide region to form the source electrode and the drain electrode each including the oxide region and the metal region.

[Claim 15]

The method for producing the field-effect transistor according to claim 12, wherein the forming the source electrode, the drain electrode, and the active layer includes:

a treatment of forming the active layer;

a treatment of forming a metal layer so that a part of the metal layer is in contact with the active layer formed; and

a treatment of oxidizing a surface of the metal layer to form the source electrode and the drain electrode each including the metal region and the oxide region so that the part of the oxide region is in contact with the active layer formed.

[Claim 16]

The method for producing the field-effect transistor according to any one of claims 12 to 15,

wherein the metal is a simple substance of a transition metal or an alloy thereof.

[Claim 17]

The method for producing the field-effect transistor according to any one of claims 12 to 15,

wherein the one or more metal oxides includes a transition metal having a positive valence and a substitutional dopant having a positive valence larger than the positive valence of the transition metal, and

wherein the metal includes an element of the transition metal and an element serving as a dopant with respect to the one or more metal oxides.

[Claim 18]

A display element comprising:

an optical control element configured to control light output according to a driving signal; and

a driving circuit including the field-effect transistor according to any one of claims 1 to 11 and configured to drive the optical control element.

[Claim 19]

The display element according to claim 18,

wherein the optical control element includes an organic electroluminescent element, an electrochromic element, a liquid crystal element, an electrophoretic element, or an electrowetting element.

[Claim 20]

An image display device configured to display an image corresponding to image data, the image display device comprising:

a plurality of display elements arranged in a form of matrix, each of the plurality of display elements being the display element according to claim 18 or 19;

a plurality of wires configured to individually apply gate voltage and signal voltage to the field-effect transistors in the plurality of display elements; and

a display control device configured to individually control the gate voltage and the signal voltage of the field-effect transistors via the plurality of wires correspondingly to the image data.

[Claim 21]

A system comprising:

the image display device according to claim 20; and

an image-data-generating device configured to generate image data based on image information to be displayed and to output the image data to the image display device.