CLAIMS

1. A catalyst comprising at least molybdenum and bismuth,

wherein

when a ratio of the amount of bismuth atoms to the amount of molybdenum atoms, calculated from ICP (inductively coupled plasma) atomic emission spectrometry is A, and a ratio of a peak area of bismuth atoms to a peak area of molybdenum atoms, measured by X-ray photoelectron spectroscopy is B, a B/A is 1.5 to 4, and

a catalyst composition is represented by the following formula:

$Mo_aBi_bFe_cM_dX_eY_fSi_gO_h$

wherein in the above formula, Mo, Bi, Fe, Si and O each represent molybdenum, bismuth, iron, silicon and oxygen, respectively; M represents at least one element selected from the group consisting of cobalt and nickel; X represents at least one element selected from the group consisting of zinc, chromium, lead, manganese, calcium, magnesium, niobium, silver, barium, tin, tantalum, tungsten, antimony, phosphorus, boron, sulfur, selenium, tellurium, cerium and titanium; Y represents at least one element selected from the group consisting of cesium, lithium, sodium, potassium, rubidium, and thallium; a, b, c, d, e, f, g and h each denote an atomic ratio of each element, and when a = 12, b = 0.01 to 3, c = 0 to 8, d = 0 to 12, e = 0 to 8, f = 0.001 to 2, and g = 0 to 20, and h is an oxygen atomic ratio required to satisfy a valence of the each component.

2. The catalyst according to claim 1, wherein the B/A value is 1.7 to 3.

3. The catalyst according to claim 1 or 2, wherein the A value is 0.02 to 0.1.

4. The catalyst according to any one of claims 1 to 3, wherein the B value is 0.04 to 0.2.

5. The catalyst according to any one of claims 1 to 4, wherein the B value is 0.07 to 0.16.

6. The catalyst according to any one of claims 1 to 5, for use in production of an α, β-unsaturated aldehyde and/or an α, β-unsaturated carboxylic acid from an alkene, an alcohol, or an ether.

7. A method of producing a catalyst comprising at least molybdenum and bismuth, wherein in the catalyst

when a ratio of the amount of bismuth atoms to the amount of molybdenum atoms, calculated from ICP (inductively coupled plasma) atomic emission spectrometry is A, and a ratio of a peak area of bismuth atoms to a peak area of molybdenum atoms, measured by X-ray photoelectron spectroscopy is B, a B/A is 1.5 to 4,

and the catalyst has a composition represented by the following formula:

$Mo_aBi_bFe_cM_dX_eY_fSi_gO_h$

wherein in the above formula, Mo, Bi, Fe, Si and O each represent molybdenum, bismuth, iron, silicon and oxygen, respectively; M represents at least one element selected from the group consisting of cobalt and nickel; X represents at least one element selected from the group consisting of zinc, chromium, lead, manganese, calcium, magnesium, niobium, silver, barium, tin, tantalum, tungsten, antimony, phosphorus, boron, sulfur, selenium, tellurium, cerium and titanium; Y represents at least one element selected from the group consisting of cesium, lithium, sodium, potassium, rubidium, and thallium; a, b, c, d, e, f, g and h each represents an atomic ratio of each element, and when a = 12, b = 0.01 to 3, c = 0 to 8, d = 0 to 12, e = 0 to 8, f = 0.001 to 2, and g = 0 to 20, and h is an oxygen atomic ratio required to satisfy a valence of the each component.

wherein the method comprises the following steps (i) to (v):

(i) mixing at least a molybdenum raw material and a bismuth raw material with a solvent to obtain a slurry (liquid A);

(ii) stirring the liquid A at a temperature of 1 to 30°C lower than the boiling point of the solvent for 20 to 90 minutes to obtain a slurry (liquid B);

(iii) stirring the liquid B at a temperature of 2°C or higher than the temperature in the step (ii) for 10 minutes to 10 hours to obtain a slurry (liquid C);

(iv) drying the liquid C to obtain a dried product; and

(v) calcining the dried product to obtain a catalyst.

8. The method of producing the catalyst according to claim 7, wherein 50% by mass or more of the total solvent is water in the step (i).

9. The method of producing the catalyst according to claim 7 or 8, wherein the temperature in the step (iii) is 1 to 20°C higher than the boiling point of the solvent.

10. The method of producing a catalyst according to any one of claims 7 to 9,

wherein the liquid B is stirred for 90 minutes to 10 hours to obtain the liquid C in the step (iii).

11. The method of producing a catalyst according to any one of claims 7 to 10, comprising producing a catalyst for use in the production of an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid from an alkene, an alcohol, or an ether.

12. A method of producing an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated aldehyde and/or the α,β-unsaturated carboxylic acid from an alkene, an alcohol or an ether by using the catalyst according to any one of claims 1 to 6.

13. A method of producing an α,β-unsaturated aldehyde and/or an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated aldehyde and/or the α,β-unsaturated carboxylic acid from an alkene, an alcohol or an ether by using a catalyst produced by the production method according to any one of claims 7 to 11.

14. A method of producing an α,β-unsaturated carboxylic acid, comprising producing the α,β-unsaturated carboxylic acid from an α,β-unsaturated aldehyde produced by the production method according to claim 12 or 13.

15. A method of producing an α,β-unsaturated carboxylic acid ester, comprising producing the α,β-unsaturated carboxylic acid ester from an α,β-unsaturated carboxylic acid produced by the production method according to any one of claims 12 to 14.