CLAIMS

The invention claimed is:

1. A method comprising:

impregnating a porous support with a water-insoluble gold compound and a water-insoluble palladium compound to yield a precipitated support by precipitating a water-soluble gold compound and a water-soluble palladium compound in the presence of the porous support;

washing the precipitated support;

reducing the water-insoluble gold compound and the water-insoluble palladium compound on the precipitated support to yield a metal-impregnated support;

impregnating the metal-impregnated support with an alkali metal promoter to yield a metal/promoter-impregnated support; and

drying the metal/promoter-impregnated support in an inert atmosphere at a temperature of from 160°C to 250°C to yield a catalyst.

2. The method of claim 1, wherein the impregnating of the porous support is performed in multiple steps comprising:

impregnating the porous support with a first water-soluble compound that is the water-insoluble gold compound or the water-insoluble palladium compound;

precipitating the first water-soluble compound in the presence of the porous support;

impregnating the porous support with a second water-soluble compound that is the water-insoluble gold compound or the water-insoluble palladium compound, wherein the first and second water-soluble compounds are different; and

precipitating the second water-soluble compound in the presence of the porous support.

3. The method of any preceding claim, wherein a molar ratio of the gold to the palladium in the catalyst is 0.01:1 to 0.7:1.

4. The method of any preceding claim, wherein an alkali metal of the alkali metal promoter is present at 0.1 wt% to 10 wt% of the catalyst on a dry basis.

5. The method of any preceding claim, wherein the alkali metal promoter is selected from the group consisting of a sodium salt, a potassium salt, or a cesium salt of formic acid, acetic acid, propionic acid, butyric acid, and any combination thereof.

6. The method of any preceding claim, wherein the reducing is in a gas phase comprising hydrogen and/or a hydrocarbon.

7. The method of claim 6, wherein the hydrocarbon is ethylene.

8. The method of claim 6, wherein the gas phase further comprises an inert carrier gas.

9. The method of claim 6, wherein the reducing is at 50°C to 250°C for 1 hour to 24 hours.

10. The method of any preceding claim, wherein the reducing is performed in a liquid phase using hydrazine hydrate.

11. The method of claim 10, wherein the reducing is at 20°C to 50°C for 1 hour to 24 hours.

12. The method of claim 1, wherein the drying of the metal/promoter-impregnated support is for 10 minutes to 1 day.

13. The method of any preceding claim, wherein the drying of the metal/promoter-impregnated support is in the presence of gas comprising nitrogen, argon, and/or air.

14. The method of any preceding claim, wherein the catalyst has a 2θ value for a peak x-ray diffraction intensity between 38° and 40° of 38.6° to 39.2°.

15. A catalyst comprising:

(a) gold, palladium, and/or gold-palladium alloy, (b) an alkali metal promoter, and (c) a porous support, wherein the catalyst has a 2θ value for a peak x-ray diffraction intensity between 38° and 40° of 38.6° to 39.2°.

16. The catalyst of claim 15, wherein a molar ratio of the gold to the palladium, cumulatively as elemental metals and alloy, in the catalyst is 0.01:1 to 0.7:1.

17. The catalyst of claim 15 or 16, wherein an alkali metal of the alkali metal promoter is present at 0.1 wt% to 10 wt% of the catalyst on a dry basis.

18. The catalyst of claim 15 or 16 or 17, wherein the alkali metal promoter is selected from the group consisting of a sodium salt, a potassium salt, or a cesium salt of formic acid, acetic acid, propionic acid, butyric acid, and any combination thereof.

19. The catalyst of claim 15 or 16 or 17 or 18, wherein the porous support is selected from the group consisting of: silica, alumina, aluminum silicates, titania, zirconia, spinels, carbon, and any combination thereof.