CLAIMS

What is claimed:

1. A method of making an alloyed multicomponent photocatalyst, comprising:
   inducing precipitation from a pre-cursor solution comprising a pre-cursor of a plasmonic material and a pre-cursor of a reactive component to form co-precipitated particles of the alloyed multicomponent photocatalyst pre-cursor;
   collecting the co-precipitated particles of the alloyed multicomponent photocatalyst pre-cursor; and
   annealing the co-precipitated particles of the alloyed multicomponent photocatalyst pre-cursor to form the alloyed multicomponent photocatalyst comprising the reactive component optically, thermally, or electronically coupled to the plasmonic material.

2. The method of claim 1, further comprising dissolving a pre-cursor of the plasmonic material and a pre-cursor of the reactive component into a solution to form the pre-cursor solution.

3. The method of claim 2, wherein a pre-cursor of a support material is also dissolved into the solution.

4. The method of claim 1, wherein precipitation is induced by contacting the pre-cursor solution with a basic solution.

5. The method of claim 4, wherein the basic solution comprises at least one of alkali metal carbonate, alkali metal bicarbonate, and alkali metal hydroxide dissolved in an aqueous solution.

6. The method of claim 1, wherein the pre-cursor of the plasmonic material and the pre-cursor of the reactive component are transition metal salts.

7. The method of claim 1, wherein the molar ratio of metal in the pre-cursor of the plasmonic material to metal in the pre-cursor of the reactive component is between 1000:1 to 10:1.

8. The method of claim 3, wherein the co-precipitated particles are between 99.9% and 20% support material.

9. The method of claim 1, wherein the annealing is performed at least partially in a reducing atmosphere.

10. The method of claim 1, wherein the annealing is performed at a temperature between 200 °C and 1000 °C.

11. A method of catalyzing a reaction, comprising:

forming an alloyed multicomponent photocatalyst pre-cursor, by a method comprising:

inducing precipitation from a pre-cursor solution comprising a pre-cursor of a support material, a pre-cursor of a plasmonic material, and a pre-cursor of a reactive component to form co-precipitated particles of the alloyed multicomponent photocatalyst pre-cursor; and

collecting the alloyed multicomponent photocatalyst pre-cursor;

loading the alloyed multicomponent photocatalyst pre-cursor into a high-temperature reaction chamber;

annealing the loaded alloyed multicomponent photocatalyst pre-cursor to form an alloyed multicomponent photocatalyst comprising the reactive component optically, thermally, or electronically coupled to the plasmonic material;

feeding reactants into the reaction chamber; and

illuminating the alloyed multicomponent photocatalyst in the reaction chamber with a light source having a wavelength overlapping a plasmon resonance of the plasmonic material.

12. The method of claim 11, wherein the alloyed multicomponent photocatalyst pre-cursor is processed into a pellet or film prior to loading into the high-temperature reaction chamber.

13. The method of claim 11, wherein the pre-cursor of the plasmonic material and the pre-cursor of the reactive component are transition metal salts.

14. The method of claim 11, wherein the molar ratio of metal in the pre-cursor of the plasmonic material to metal in the pre-cursor of the reactive component is between 1000:1 to 10:1.

15. The method of claim 11, wherein the annealing is performed at least partially in a reducing atmosphere.

16. The method of claim 11, wherein the annealing is performed at a temperature between 200 °C and 1000 °C.

17. The method of claim 11, wherein the plasmonic material is selected from gold (Au), silver (Ag), copper (Cu), aluminum (Al), and alloys including said elements.

18. The method of claim 11, wherein the reactive component is selected from palladium (Pd), platinum (Pt), ruthenium (Ru), rhodium (Rh), nickel (Ni), iron (Fe), cobalt (Co), iridium (Ir), osmium (Os), titanium (Ti), vanadium (V), indium (In).

19. The method of claim 11, wherein the alloyed multicomponent photocatalyst has the reactive component alloyed at the surface of the plasmonic material.

20. The method of claim 11, wherein the reaction is one of methane steam reforming, methane dry reforming, ammonia decomposition, nitrous oxide decomposition, reverse water gas shift, water gas shift, reduction of acetylene, ammonia synthesis, and Fisher-Tropsch synthesis.