CLAIMS

1. A supported catalyst comprising a carrier, phosphorus, at least one Group VIB metal, atleast one Group VIII metal, and a polymer, where

the molar ratio of phosphorus to Group VIB metal is about 1:1.5 to less than about 1:12, the molar ratio of the Group VIB metal to the Group VIII metal is about 1:1 to about 5:1, and

the polymer has a carbon backbone and comprises functional groups having at least one heteroatom, and the polymer loading is about 1.5 wt% or more, wherein the functional groups are selected from hydroxyl groups, carboxyl groups, carbonyl groups, amine groups, amide groups, nitrile groups, amino acid groups, phosphate groups, thiol groups, sulfonic acid groups, and mixtures of two or more of the foregoing.

2. A catalyst as in Claim 1 wherein said carrier is silica, alumina, silica-alumina, alumina with silica-alumina dispersed therein, alumina-coated silica, or silica-coated alumina, and/or wherein the functional groups of the polymer are carboxylic acid groups.

3. A catalyst as in Claim 1 wherein the molar ratio of phosphorus to Group VIB metal is about 1:2.5 to less than about 1:12.

4. A catalyst as in Claim 1 wherein the polymer is polymaleic acid, polyfumaric acid, or polyacrylic acid.

5. A catalyst as in any of Claims 1, 2, 3, or 4 wherein said Group VIB metal is molybdenum and/or tungsten, and/or wherein said Group VIII metal is nickel and/or cobalt.

6. A catalyst as in any of Claims 1, 2, 3, or 4 wherein the catalyst has a polymer loading of about 1.5 wt% or more, relative to the total weight of the other components in the catalyst.

7. A catalyst as in any of Claims 1, 2, 3, or 4 wherein the carrier is about 40 wt% to about 80 wt% of the catalyst, relative to the total weight of the carrier, hydrogenation metals, and phosphorus, where the hydrogenation metals and phosphorus are expressed as their oxides.

8. A method for hydrotreating, hydrodenitrogenation, and/or hydrodesulfurization, which method comprises contacting a hydrocarbon feed and a catalyst of any of Claims 1, 2, 3, 4, 5, 6, or 7.

9. A process for forming a supported catalyst, which process comprises

I) bringing together components in any of the following combinations:

a-i) a carrier, one or more monomer species, a polar solvent, and optionally an initiator,

b-i) a carrier, one or more monomer species, at least one phosphorus compound, at least one Group VIB metal compound, and at least one Group VIII metal compound, and optionally an initiator, or

c-i) a carrier and an impregnation solution, forming an impregnated carrier, followed by mixing the impregnated carrier with one or more monomer species and optionally an initiator,

to form a monomer-containing mixture, where said monomer species is soluble in the polar solvent and has carbon-carbon unsaturation and at least one functional group comprising at least one heteroatom selected from nitrogen, oxygen, phosphorus, and sulfur and mixtures of two or more of the foregoing; and

II) polymerizing at least a portion of said monomer species in the monomer-containing mixture to form a polymerized product;

III) when I) does not include at least one phosphorus compound, at least one Group VIB metal compound, and at least one Group VIII metal compound, either

a-iia) contacting an impregnation solution and the monomer-containing mixture during the polymerizing in II), or

a-iib) contacting the polymerized product and an impregnation solution;

to form a supported catalyst, where the molar ratio of phosphorus to Group VIB metal is about 1:1.5 to less than about 1:12, where the molar ratio of the Group VIB metal to the Group VIII metal is about 1:1 to about 5:1, where said impregnation solution comprises a polar solvent, phosphorus, at least one Group VIB metal, and at least one Group VIII metal, where a polymer is formed during the polymerizing, the polymer has a carbon backbone and comprises functional groups having at least one heteroatom, and the polymer loading is about 1.5 wt% or more.