CLAIMS:

~~1. A catalyst precursor composition comprising at least one metal from~~ Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, and a reaction product formed from (i) a first organic compound containing at least one amine group, and (ii) a second organic compound separate from said first organic compound and containing at least one carboxylic acid group.

2. A process for producing an amide-containing catalyst precursor composition, the process comprising:

(a) treating a catalyst precursor composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, with a first organic compound containing at least one amine group and a second organic compound separate from said first organic compound and containing at least one carboxylic acid group to form an organically treated precursor catalyst composition; and

(b) heating said organically treated precursor catalyst composition at a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to react to form an amide *in situ* but not for so long that the amide so formed decomposes, thereby forming the amide-containing catalyst precursor composition.

3. A process for producing a catalyst precursor composition containing an *in situ* formed amide and/or *in situ* formed unsaturated carbon atoms, the process comprising:

(a) treating a catalyst precursor composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, with a first organic compound containing at least one amine group and a second organic compound separate from said first organic compound and containing at least one carboxylic acid group to ~~form an organically treated precursor catalyst composition; and~~

(b) heating said organically treated precursor catalyst composition at a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to react to form an *in situ* amide, additional *in situ* unsaturated carbon atoms not present in the first or second organic compounds, or both, but not for so long that: (i) any amide substantially decomposes, and/or (ii) more than 50% by weight of the combined first and second organic compounds are volatilized, thereby forming a catalyst precursor composition containing an *in situ* formed amide and/or *in situ* formed unsaturated carbon atoms.

4. The process of embodiment 2 or embodiment 3, wherein (a) is accomplished by one or more of:

first treating the catalyst precursor composition with said first organic compound and second with said second organic compound;

first treating the catalyst precursor composition with said second organic compound and second with said first organic compound; and

treating the catalyst precursor composition simultaneously with said first organic compound and with said second organic compound.

5. The catalyst precursor composition or the process of any one of the previous embodiments, wherein said at least one metal from Group 6 is Mo, W, or a combination thereof, and wherein said at least one metal from Groups 8-10 is Co, Ni, or a combination thereof.

6. The catalyst precursor composition or the process of any one of the previous embodiments, wherein said catalyst precursor composition further comprises at least one metal from Group 5 of the Periodic Table of the Elements, for example V, Nb, or a combination thereof.

7. The catalyst precursor composition or the process of any one of the previous embodiments, wherein said first organic compound comprises at least 10 carbon atoms, for example comprises a primary monoamine having from 10 to 30 carbon atoms, and/or wherein said second organic compound comprises at least 10 carbon atoms, for example comprises only one carboxylic acid group and has from 10 to 30 carbon atoms.

8. A bulk mixed metal catalyst precursor composition produced by heating the composition of any one of embodiments 1 and 5-7 to a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to form a reaction product *in situ* that contains an amide moiety, unsaturated carbon atoms not present in the first or second organic compounds, or both.

9. A bulk mixed metal hydroprocessing catalyst composition produced by sulfiding the catalyst precursor composition of embodiment 8.

10. The process of any one of embodiments 2-7, wherein the amide-containing catalyst precursor composition is a bulk metal hydroprocessing catalyst precursor composition consisting essentially of the reaction product amide, an oxide form of the at least one metal from Group 6, an oxide form of the at least one metal from Groups 8-10, and optionally about 20 wt% or less of a binder.

11. A process for producing a sulfided hydroprocessing catalyst composition, comprising sulfiding the amide-containing catalyst precursor composition made according to the process of any one of embodiments 2-7 and 10 under sulfidation conditions sufficient to produce the sulfided hydroprocessing catalyst composition.

12. A sulfided hydroprocessing catalyst composition made according to the process of embodiment 11 or made by a process comprising sulfiding the amide-containing catalyst precursor composition of any one of embodiments 1 and 5-9 under sulfidation conditions sufficient to produce the sulfided hydroprocessing catalyst composition.

13. The process of any one of embodiments 2-7 and 10-11, wherein the first and second organic compounds collectively comprise a total of at least 15 carbon atoms.

14. The process of any one of embodiments 2-7, 10-11, and 13, wherein one or more of the following are satisfied:

the catalyst precursor composition exhibits a content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of at least 29%; the catalyst precursor composition exhibits a content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of up to about 70%;

the catalyst precursor composition exhibits an increase in content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of at least about 17%, compared to a collective content of unsaturated carbon atoms present in the first and second organic compounds;

the catalyst precursor composition exhibits an increase in content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of up to about 60%, compared to a collective content of unsaturated carbon atoms present in the first and second organic compounds;

the catalyst precursor composition exhibits a ratio of unsaturated carbon atoms to aromatic carbon atoms, as measured according to peak area ratios using infrared spectroscopic techniques of a deconvoluted peak centered from about 1700 cm^{-1} to about 1730 cm^{-1}, compared to a deconvoluted peak centered from about 1380 cm^{-1} to about 1450 cm^{-1}, of at least 0.9; and

the catalyst precursor composition exhibits a ratio of unsaturated carbon atoms to aromatic carbon atoms, as measured according to peak area ratios using infrared spectroscopic techniques of a deconvoluted peak centered from about 1700 cm^{-1} to about 1730 cm^{-1}, compared to a deconvoluted peak centered from about 1380 cm^{-1} to about 1450 cm^{-1}, of up to 15.

15. A process for producing a sulfided hydroprocessing catalyst composition, comprising sulfiding the catalyst precursor composition made according to the process of any one of embodiments 2-7, 10-11, and 13-14 under conditions sufficient to produce the sulfided hydroprocessing catalyst composition, wherein one or more of the following are satisfied:

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA of at

least 57% greater than a sulfided catalyst composition that has not been treated using first and second organic compounds;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA of up to 500% greater than a sulfided catalyst composition that has not been treated using first and second organic compounds;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA at least 10% greater than a sulfided catalyst composition that has been treated with only the first organic compound or only the second organic compound;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA up to 200% greater than a sulfided catalyst composition that has been treated with only the first organic compound or only the second organic compound;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA at least 30% greater than a sulfided catalyst composition that has been treated with only a single organic compound having less than 10 carbon atoms; and

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA up to 500% greater than a sulfided catalyst composition that has been treated with only a single organic compound having less than 10 carbon atoms.

CLAIMS:

1. A bulk mixed metal catalyst precursor composition produced by heating a composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, and a reaction product formed from (i) a first organic compound containing at least one amine group, and (ii) a second organic compound separate from said first organic compound and containing at least one carboxylic acid group to a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to form a reaction product *in situ* that contains an amide moiety, unsaturated carbon atoms not present in the first or second organic compounds, or both.

2. A bulk mixed metal hydroprocessing catalyst composition produced by sulfiding the catalyst precursor composition of claim 1.

3. A process for producing an amide-containing catalyst precursor composition, the process comprising:

(a) treating a catalyst precursor composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, with a first organic compound containing at least one amine group and a second organic compound separate from said first organic compound and containing at least one carboxylic acid group to form an organically treated precursor catalyst composition; and

(b) heating said organically treated precursor catalyst composition at a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to react to form an amide *in situ* but not for so long that the amide so formed decomposes, thereby forming the amide-containing catalyst precursor composition.

4. The process of claim 3, wherein (a) is accomplished by first treating the catalyst precursor composition with said first organic compound and second with said second organic compound.

5. The process of claim 3, wherein (a) is accomplished by first treating the catalyst precursor composition with said second organic compound and second with said first organic compound.

6. The process of claim 3, wherein (a) is accomplished by treating the catalyst precursor composition simultaneously with said first organic compound and with said second organic compound.

7. The process of claim 3, wherein said at least one metal from Group 6 is Mo, W, or a combination thereof, and wherein said at least one metal from Groups 8-10 is Co, Ni, or a combination thereof.

8. The process of claim 3, wherein said first organic compound comprises at least 10 carbon atoms.

9. The process of claim 3, wherein said second organic compound comprises at least 10 carbon atoms.

10. The process of claim 3, wherein the amide-containing catalyst precursor composition is a bulk metal hydroprocessing catalyst precursor composition consisting essentially of the reaction product, an oxide form of the at least one metal from Group 6, an oxide form of the at least one metal from Groups 8-10, and optionally about 20 wt % or less of a binder.

11. A process for producing a sulfided hydroprocessing catalyst composition, comprising sulfiding the amide-containing catalyst precursor composition made according to the process of claim 3 under conditions sufficient to produce the sulfided hydroprocessing catalyst composition.

12. A process for producing a sulfided hydroprocessing catalyst composition, comprising sulfiding the amide-containing catalyst precursor composition made according to the process of claim 10 under conditions sufficient to produce the sulfided hydroprocessing catalyst composition.

13. An amide-containing catalyst precursor composition made according to the process of claim 3.

14. A sulfided hydroprocessing catalyst composition made according to the process of claim 12.

15. A process for producing a catalyst precursor composition containing an *in situ* formed amide and/or *in situ* formed unsaturated carbon atoms, the process comprising:

(a) treating a catalyst precursor composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, with a first organic compound containing at least one amine group and a second organic compound separate from said first organic compound and containing at least one carboxylic acid group to form an organically treated precursor catalyst composition; and

(b) heating said organically treated precursor catalyst composition at a temperature from about 195°C to about 250°C for a time sufficient for the first and second organic compounds to react to form an *in situ* amide, additional *in situ* unsaturated carbon atoms not present in the first or second organic compounds, or both, but not for so long that:

(i) any amide substantially decomposes, and/or

(ii) more than 50% by weight of the combined first and second organic compounds are volatilized, thereby forming a catalyst precursor composition containing an *in situ* formed amide and/or *in situ* formed unsaturated carbon atoms.

16. The process of claim 15, wherein the first and second organic compounds collectively comprise a total of at least 15 carbon atoms.

17. The process of claim 15, wherein one or more of the following are satisfied:

the catalyst precursor composition exhibits a content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of at least 29%;

the catalyst precursor composition exhibits a content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of up to about 70%;

the catalyst precursor composition exhibits an increase in content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of at least about 17%, compared to a collective content of unsaturated carbon atoms present in the first and second organic compounds;

the catalyst precursor composition exhibits an increase in content of unsaturated carbon atoms, as measured according to peak area comparisons using ^{13}C NMR techniques, of up to about 60%, compared to a collective content of unsaturated carbon atoms present in the first and second organic compounds;

the catalyst precursor composition exhibits a ratio of unsaturated carbon atoms to aromatic carbon atoms, as measured according to peak area ratios using infrared spectroscopic techniques of a deconvoluted peak centered from about 1700 cm^{-1} to about 1730 cm^{-1}, compared to a deconvoluted peak centered from about 1380 cm cm^{-1} to about 1450 cm^{-1}, of at least 0.9; and

the catalyst precursor composition exhibits a ratio of unsaturated carbon atoms to aromatic carbon atoms, as measured according to peak area ratios using infrared spectroscopic techniques of a deconvoluted peak centered from about 1700 cm^{-1} to about 1730 cm^{-1}, compared to a deconvoluted peak centered from about 1380 cm^{-1} to about 1450 cm^{-1}, of up to 15.

18. A process for producing a sulfided hydroprocessing catalyst composition, comprising sulfiding the catalyst precursor composition made according to the process of claim 17 under conditions sufficient to produce the sulfided hydroprocessing catalyst composition, wherein one or more of the following are satisfied:

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA of at least 57% greater than a sulfided catalyst composition that has not been treated using first and second organic compounds;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA of up to 500% greater than a sulfided catalyst composition that has not been treated using first and second organic compounds;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA at least 10% greater than a sulfided catalyst composition that has been treated with only the first organic compound or only the second organic compound;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA up to 200% greater than a sulfided catalyst composition that has been treated with only the first organic compound or only the second organic compound;

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA at least 30% greater than a sulfided catalyst composition that has been treated with only a single organic compound having less than 10 carbon atoms; and

upon exposure of the sulfided hydroprocessing catalyst composition to a vacuum gasoil feedstock under hydroprocessing conditions, the sulfided hydroprocessing catalyst composition exhibits a hydrodenitrogenation RMA up to 500% greater than a sulfided catalyst composition that has been treated with only a single organic compound having less than 10 carbon atoms.

19. A bulk mixed metal catalyst precursor composition according to claim 1 comprising only one metal from Group 6 of the Periodic Table of the Elements.

20. A bulk mixed metal catalyst precursor composition according to claim 19 in which the metal from Group 6 of the Periodic Table of the Elements is tungsten.

21. A bulk mixed metal catalyst precursor composition according to claim 19 comprising one metal from Group 8 of the Periodic Table of the Elements.

22. A bulk mixed metal catalyst precursor composition according to claim 21 in which the metal from Group 8 of the Periodic Table of the Elements is nickel.

23. A bulk mixed metal catalyst precursor composition according to claim 1 in which the composition comprising at least one metal from Group 6 of the Periodic Table of the Elements, at least one metal from Groups 8-10 of the Periodic Table of the Elements, and the reaction product formed from the first and second organic compounds is heated at a temperature from about 195°C to about 250°C in an oxidizing atmosphere.

24. A bulk mixed metal hydroprocessing catalyst composition produced by sulfiding the catalyst precursor composition of claim 23.

25. A process according to claim 3 in which the heating of the organically treated precursor catalyst composition is carried out in an oxidizing atmosphere.

26. An amide-containing catalyst precursor composition made according to the process of claim 25.

27. A sulfided hydroprocessing catalyst composition produced by sulfiding the catalyst precursor composition of claim 26.

28. The process of claim 16 in which the first and second organic compounds collectively comprise a total of at least 20 carbon atoms.

29. The process of claim 28 in which the first and second organic compounds collectively comprise a total of at least 25 carbon atoms.

30. An amide-containing catalyst precursor composition made according to the process of claim 28.

31. An amide-containing catalyst precursor composition made according to the process of claim 29.

32. A sulfided hydroprocessing catalyst composition produced by sulfiding the catalyst precursor composition of claim 30.