CLAIMS

1. A method for preparing mixed-metal oxide particles comprising less than 5 wt%, by weight of the mixed-metal oxide particles, of spinel-phases having a formula MAl_2O_4, the process comprising:

heating adamantane-intercalated layered double-hydroxide (LDH) particles up to a reaction temperature of from 400 °C to 800 °C to form mixed-metal oxide particles,

where:

the adamantane-intercalated LDH particles have

a length and a width;

a general formula $[M_{1-x}Al_x(OH)_2](A)_x \cdot mH_2O$, where x is from 0.14 to 0.33, m is from 0.33 to 0.50, M is chosen from Mg, Ca, Co, Ni, Cu, or Zn, and A is adamantane carboxylate; and

an aspect ratio greater than 100 where the aspect ratio is defined by the width of an adamantane-intercalated LDH particle divided by the thickness of the adamantane-intercalated LDH particle; and

the mixed-metal oxide particles comprise a mixed-metal oxide phase containing M, Al and carbon.

2. The method of claim 1 where the mixed-metal oxide particles further comprise an oxide phase having a formula MO.

3. The method of claim 1 where the mixed-metal oxide particles do not include any spinel-phases having a formula MAl_2O_4, preferably where the mixed-metal oxide phase is positioned between chains of the oxide phase.

4. The method of claim 1 where the mixed-metal oxide particles consist essentially of the mixed-metal oxide phase and an oxide phase having a formula MO, and the mixed-metal oxide particles do not include any spinel-phase having a formula MAl_2O_4.

5. The method of claim 1 where the heating up to the reaction temperature is at a heating rate of 4 to 6 °C/min, preferably where the heating involves holding at the reaction temperature for at least 4 hours.

6. The method of claim 1 where the heating of the adamantane-intercalated layered double-hydroxide (LDH) particles is from an initial temperature of 20 °C to 30 °C to the reaction temperature of 400 °C to 800 °C.

7. The method of claim 5, where the heating up to the reaction temperature is at a heating rate of 4 to 6 °C/min and where M is Mg.

8. Mixed-metal oxide particles comprising:

at least one mixed-metal oxide phase containing M, Al, and carbon, where M is chosen from Mg, Ca, Co, Ni, Cu, or Zn; and

at least one oxide phase having a formula MO, where the mixed-metal oxide phase is sandwiched between chains of the oxide phase,

where the mixed-metal oxide particles comprises less than 5 wt%, by weight of the mixed-metal oxide particles, of spinel-phases having a formula MAl_2O_4.

9. The mixed-metal oxide particles of claim 8, where the mixed-metal oxide particles do not include any spinel-phase having a formula MAl_2O_4.

10. The mixed-metal oxide particles of claim 9 where the mixed-metal oxide particles define a Powder X-Ray Diffraction (PXRD) profile having a signature peak at 13.0 +/-0.5 at 800 °C.

11. The mixed-metal oxide particles of claim 9 where the mixed-metal oxide particles consist essentially of the layers of the mixed-metal oxide phase and the oxide phase.

12. The mixed-metal oxide particles of claim 9 where M is Mg.

13. A method of removing constituents from a process stream comprising:

contacting the process stream with a sorbent, where the sorbent comprises mixed-metal oxide particles comprising:

at least one mixed-metal oxide phase containing M, Al, and carbon, where M is chosen from Mg, Ca, Co, Ni, Cu, or Zn; and

at least one oxide phase having a formula MO, where the mixed-metal oxide phase is sandwiched between chains of the oxide phase, and where the mixed-metal oxide particles do not include any spinel-phase having a formula MAl_2O_4.

14. The method of claim 13 where M is Mg.

15. The method of claim 14 where the process stream is: a gas stream and the removed constituent is carbon dioxide; or where the process stream is a gas stream or a water stream and the removed constituent is a toxic ion, preferably where the toxic ion is one or more of a phosphate, arsenate, chromate, bromide, iodide, and sulfide.