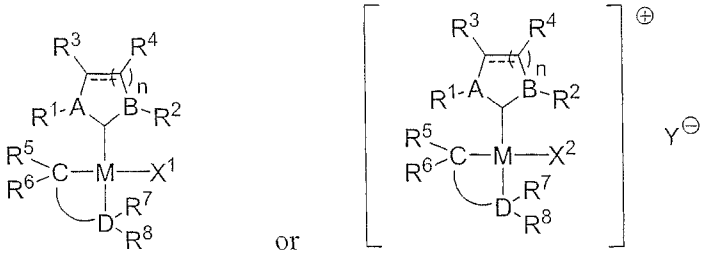
What is claimed:

1. A composition of matter, comprising a compound having one of the following structures,

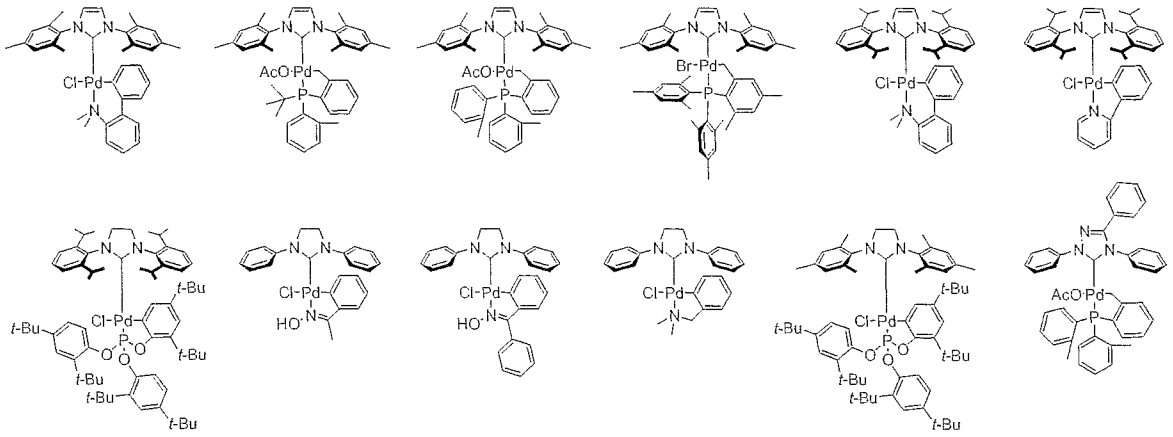


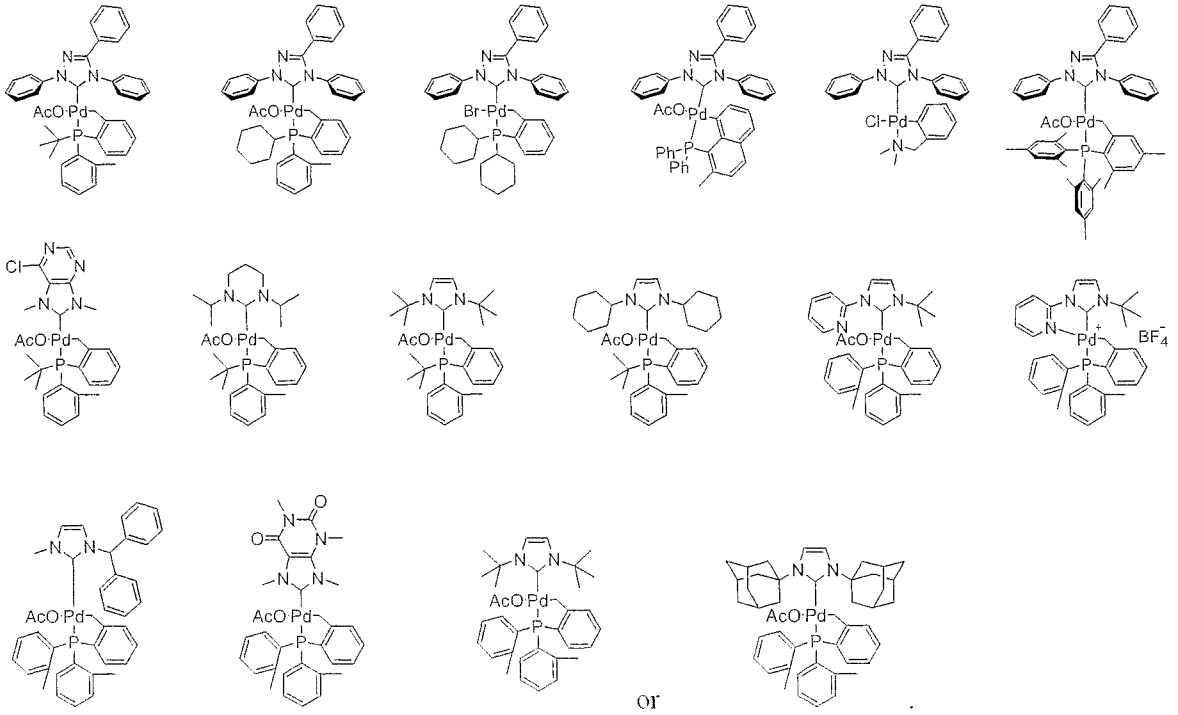
or

,

wherein M is Pd, Pt, or Ru; each R^{1-8} is independently absent, hydrogen, alkyl, cycloalkyl, heteroalkyl, cycloheteroalkyl, aryl, heteroaryl, or a substituted derivative thereof, or wherein any two of R^{1-8} are joined to form a cycloalkyl, cycloheteroalkyl, aryl, heteroaryl, or substituted derivative thereof; A is carbon or a heteroatom; B is a heteroatom; C is ~~alkyl or~~ aryl ; D is a heteroatom; X^1 is halide, sulfonate, or carboxylate; X^2 is a neutral ligand; Y is a counterion; ⌒ is alkyl, heteroalkyl, aryl, heteroaryl, or a substituted derivative thereof; ⎓ is a single bond or double bond; and n is an integer between 1 and 3;

wherein the compound does not have the following structure,





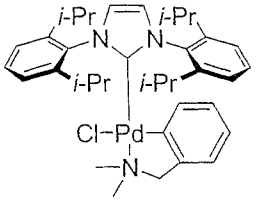
2. A composition as in claim 1, wherein each R^{1-8} is independently hydrogen, alkyl, cycloalkyl, alkoxy, amino, aryl, heteroaryl, or substituted derivatives thereof; A is carbon, nitrogen, ~~phosphorus, oxygen, or sulfur~~; B is nitrogen, phosphorus, oxygen, or sulfur; D is nitrogen, phosphorus, arsenic, antimony, oxygen, sulfur, selenium, or tellurium; and n is an integer between 1 and 3.

3. A composition as in claim 1, wherein A and B are nitrogen; D is nitrogen, phosphorus, or sulfur; R^1 and R^2 are aromatic rings optionally substituted with methyl, ethyl, isopropyl, t-butyl, methoxy, isopropoxy, trifluoromethyl, or phenyl; R^3 and R^4 are phenyl, t-butyl, or are joined together to form a six-membered ring; R^5 and R^6 are hydrogen, t-butyl, methoxy, trifluoromethyl, or are joined together to form an aryl ring; R^7 and R^8 are methyl, isopropyl, t-butyl, phenyl, phenoxy, hydroxyl, R^7 and R^8 are joined together to form a ring; or at least one of R^7 and R^8 is joined to a portion of ⌒ to form a ring.

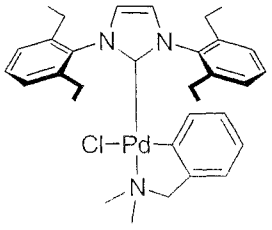
4. A composition as in claim 1, wherein M is Pd, R^1 and R^2 are aromatic rings substituted with methyl, isopropyl, or combinations thereof, A and B are nitrogen, and D

is nitrogen or phosphorus.

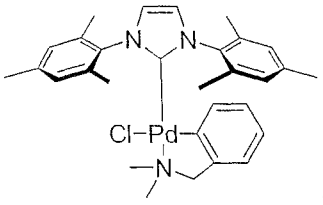
5. A composition as in claim 1, wherein the compound has the following structure,



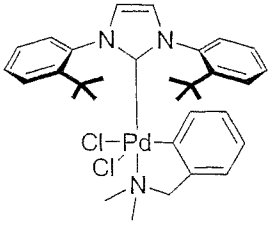
6. A composition as in claim 1, wherein the compound has the following structure,



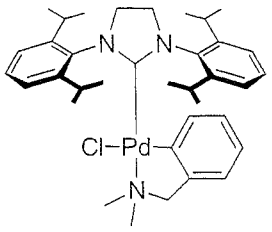
7. A composition as in claim 1, wherein the compound has the following structure,



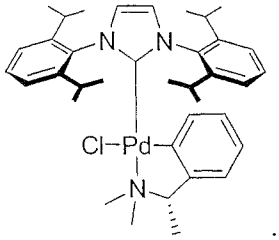
8. A composition as in claim 1, wherein the compound has the following structure,



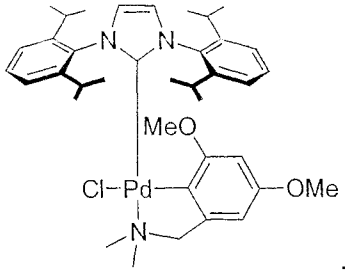
9. A composition as in claim 1, wherein the compound has the following structure,



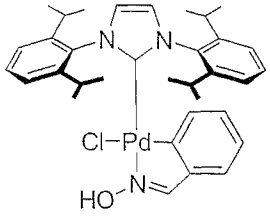
10. A composition as in claim 1, wherein the compound has the following structure,



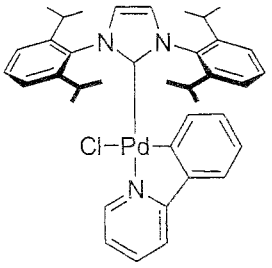
11. A composition as in claim 1, wherein the compound has the following structure,



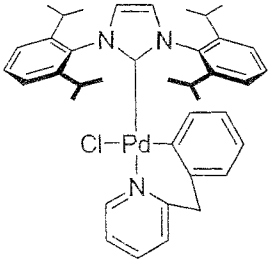
12. A composition as in claim 1, wherein the compound has the following structure,



13. A composition as in claim 1, wherein the compound has the following structure,



14. A composition as in claim 1, wherein the compound has the following structure,



15. A composition as in claim 1, wherein the counterion is BF_4, PF_6, or Ar_4B, wherein Ar is aryl.

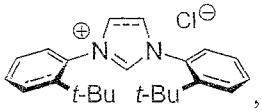
16. A composition as in claim 1, wherein the neutral ligand comprises a nitrile, ether, or alcohol.

17. A composition as in claim 1, wherein the neutral ligand is acetonitrile, tetrahydrofuran, or methanol.

18. A composition as in claim 1, wherein the compound is stable in the presence of oxygen.

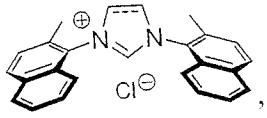
19. A composition as in claim 1, wherein the compound is stable in the presence of water.

20. A composition of matter, comprising a compound having the following structure,



wherein ⎓ is a single bond or double bond.

21. A composition of matter, comprising a compound having the following structure,



,

wherein ⎓ is a single bond or double bond.