CLAIMS

WHAT IS CLAIMED IS:

1. A catalyst for ammonia decomposition, comprising:

   a doped support consisting of an inert support and an active layer on the surface of the support,

   wherein the inert support comprises a monoclinic structure of a first metal oxide, with a melting point of at least 2000 °C, a packing density ranging from about 0.7 g/mL to about 1.4 g/mL, and a thermal expansion coefficient of at least about 6 e^{-6}/ Kelvin and not more than about 12 e^{-6}/Kelvin;

   wherein the active layer comprises a tetragonal network structure of a solid solution of at least two metal oxides, comprising the first metal oxide of the inert support and a second metal oxide deposited on the surface of the inert support; and

   wherein the active layer further comprises an alkali metal and ruthenium (Ru);

   wherein a concentration of the Ru ranges from about 0.5 wt% to about 5 wt% with respect to the mass of the catalyst.

2. The catalyst of claim 1, wherein the first metal oxide comprises zirconia (ZrO_2).
3. The catalyst of claim 2, wherein the second metal oxide comprises ceria (CeO_2).
4. The catalyst of claim 3, wherein a concentration of Ce ranges from about 5 mols to about 20 mols per 100 mols of ZrO_2.
5. The catalyst of claim 3, wherein a molar ratio of Ce to Zr in the active layer is at least about 1:15 and not more than about 1:2.
6. The catalyst of claim 3, wherein a molar ratio of the alkali metal to Ce ranges from about 0.1:1 to about 3:1.
7. The catalyst of claim 1, wherein the alkali metal is potassium (K).
8. The catalyst of claim 1, wherein the concentration of Ru is at most about 2 wt% with respect to the mass of the catalyst.
9. A method of producing a catalyst for ammonia decomposition, comprising:
   (a) doping an inert support comprising a first metal oxide by depositing a second metal oxide or precursor(s) thereof, and an alkali metal or precursor(s) thereof, onto a surface of the inert support;

wherein the inert support comprises a monoclinic structure with a melting point of at least 2000 °C, a packing density ranging from about 0.7 g/mL to about 1.4 g/mL, and a thermal expansion coefficient of at least about 6 e^{-6}/Kelvin and not more than about 12 e^{-6}/Kelvin;

(b) contacting the doped support with a gas comprising nitrogen (N_2) at a temperature ranging from about 600 °C to about 1000 °C for at least about 1 hour and not more than about 50 hours, to form an active layer comprising a tetragonal network structure of a solid solution of the first metal oxide and the second metal oxide on the surface of the inert support;

(c) depositing ruthenium (Ru) or precursor(s) thereof onto the active layer;

wherein a concentration of the ruthenium (Ru) ranges from about 0.5 wt% to about 5 wt% with respect to the mass of the catalyst; and

(d) contacting the doped support with a gas comprising hydrogen (H_2) at a temperature ranging from about 600 °C to about 1000 °C for at least about 1 hour and not more than about 50 hours.

10. The method of claim 9, wherein the first metal oxide comprises zirconia (ZrO_2).
11. The method of claim 10, wherein the second metal oxide comprises ceria (CeO_2).
12. The method of claim 11, wherein a concentration of Ce ranges from about 5 mols to about 20 mols per 100 mols of ZrO_2.
13. The method of claim 11, wherein a molar ratio of Ce to Zr in the active layer is at least about 1:15 and not more than about 1:2.
14. The method of claim 11, wherein a molar ratio of the alkali metal to Ce ranges from about 0.1:1 to about 3:1.
15. The method of claim 9, wherein the alkali metal is potassium (K).
16. The method of claim 9, wherein the concentration of Ru is not more than about 2 wt% with respect to the mass of the catalyst.
17. The method of claim 9, wherein the ruthenium precursor is ruthenium nitrosyl nitrate ($Ru(NO)(NO_3)_3$).
18. The method of claim 9, wherein the inert support comprises beads or pellets;

wherein the beads or the pellets comprise at least one of (i) a diameter ranging from about 0.1 millimeters (mm) to about 10 mm, or (ii) a surface area per unit mass ranging from about 50 m^2/g to about 500 m^2/g.

19. A catalyst prepared according to the method of claim 9, wherein the catalyst has an ammonia (NH_3) conversion efficiency of at least about 80% at a temperature of 450 °C, a space velocity of about 10000 $mL_{NH3} \bullet mL_{cat}^{-1}$, and a pressure ($P_{NH3}$) of 1 atmosphere (atm).