CLAIMS

1. A structured monolithic catalyst for reducing NOx emission in flue gas, comprising: a structured monolithic carrier and a coating of active components disposed on inner surface and/or outer surface of the structured monolithic carrier, wherein, based on the total weight of the catalyst, the coating of active components is presented in an amount of 10-50 wt%, wherein the coating of active components comprises active metal components and a substrate, wherein the active metal components comprise a first metal element, a second metal element, a third metal element and a fourth metal element, wherein the first metal element is selected from the group consisting of the non-noble metal elements of the Group VIII, wherein the first metal element includes Fe and Co, wherein the weight ratio of Fe and Co is 1 : (0.05-20) on an oxide basis, wherein the second metal element is at least one selected from the group consisting of the metal elements of the Group IA and/or IIA, wherein the third metal element is at least one selected from the group consisting of the non-noble metal elements of the Groups IB to VIIB, and wherein the fourth metal element is at least one selected from the group consisting of the noble metal elements,

wherein the structured monolithic carrier is selected from a monolithic carrier with parallel channels opened at both ends;

wherein the substrate is at least one selected from the group consisting of alumina, silica-alumina, zeolite, spinel, kaolin, diatomite, perlite and perovskite; and

wherein at least part of Fe in the catalyst is presented in a form of iron carbide, and at least part of Co in the composition is presented in a form of elemental cobalt.

2. The structured monolithic catalyst of claim 1, wherein, based on the total weight of the catalyst, the coating of active ingredients is presented in an amount of 15-40 wt%, 20-35 wt%,

2-30 wt%, 5-25 wt%, or 7-20 wt%

3. The structured monolithic catalyst of claim 1 or 2, wherein,

based on the total weight of the coating of active ingredients, the substrate is in an amount of 10-90 wt%, and on an oxide basis, the first metal element is in an amount of 0.5-50 wt%, the second metal element is in an amount of 0.5-20 wt%, the third metal element is in an amount of 0.5-20 wt%, and on an element basis, the fourth metal element is in an amount of 0.001-0.15 wt%,

preferably, based on the total weight of the coating of active ingredients, the substrate is in an amount of 50-90 wt%, and on an oxide basis, the first metal element is in an amount of 3-30 wt%, the second metal element is in an amount of 1-20 wt%, the third metal element is in an amount of 1-10 wt%, and on an element basis, the fourth metal element is in an amount of 0.005-0.1 wt%,

further preferably, based on the total weight of the coating of active ingredients, the substrate is in an amount of 55-85 wt%, and on an oxide basis, the first metal element is in an amount of 5-25 wt%, the second metal element is in an amount of 5-15 wt%, the third metal element is in an amount of 2-8 wt%, and on an element basis, the fourth metal element is in an amount of 0.01-0.08 wt%.

4. The structured monolithic catalyst of any one of claims 1-3, wherein, on an oxide basis, the weight ratio of Fe and Co is 1:(0.1-10), preferably 1:(0.3-3), further preferably 1:(0.5-2).

5. The structured monolithic catalyst of any one of claims 1-4, wherein the XRD pattern of the catalyst includes diffraction peaks at 2θ of 42.6°, 44.2° and 44.9°

6. The structured monolithic catalyst of any one of claims 1-5, wherein, the second metal element is at least one selected from the group consisting of Na, K, Mg and Ca, preferably K and/or Mg, most preferably Mg;

the third metal element is at least one selected from the group

consisting of Cu, Zn, Ti, Zr, V, Cr, Mo, W, Mn and rare earth elements, preferably at least one selected from the group consisting of Zr, V, W, Mn, Ce and La, most preferably Mn;

the fourth metal element is at least one selected from the group consisting of Pt, Ir, Pd, Ru and Rh, most preferably Ru.

7. The structured monolithic catalyst of any one of claims 1-6, wherein, the substrate is at least one selected from the group consisting of alumina, spinel and perovskite, and further preferably alumina;

preferably, the structured monolithic carrier has a pore density in the cross section of 20-900 pores/square inch and an opening rate in the cross section of 20-80%;

preferably, the structured monolithic carrier is at least one selected from the group consisting of a cordierite honeycomb carrier, a a mullite honeycomb carrier, a diamond honeycomb carrier, a corundum honeycomb carrier, a zirconium corundum honeycomb carrier, a quartz honeycomb carrier, a nepheline honeycomb carrier, a feldspar honeycomb carrier, an alumina honeycomb carrier and a metal alloy honeycomb carrier.

8. A method for preparing a structured monolithic catalyst for reducing NOx emission in flue gas, comprising:

in the first scheme:

(1) making a slurry by mixing a source of a substrate, a precursor of a first metal element, a precursor of a second metal element, a precursor of a third metal element, a precursor of a fourth metal element, and water, to obtain a coating slurry of active components, and

(2) coating a structured monolithic carrier with the coating slurry of active components, and then subjected to drying and the first calcining, to obtain the coating of active components disposed on inner surface and/or outer surface of the structured monolithic

carrier, or

in the second scheme

a) making a slurry by mixing a source of a substrate, a precursor of a first metal element, a precursor of a second metal element, a precursor of a third metal element, and water, to obtain a first slurry,

b) coating a structured monolithic carrier with the first slurry, and then subjected to drying and the second calcining, to form a coating comprising parts of active components on inner surface and/or outer surface of the structured monolithic carrier, to obtain a semi-finished catalyst, and

c) coating the semi-finished catalyst obtained in the step b) with a solution comprising a precursor of a fourth metal element, and then subjected to drying and/or the third calcining, to obtain the coating of active components disposed on inner surface and/or outer surface of the structured monolithic carrier,

wherein the first metal element is selected from the group consisting of the non-noble metal elements of the Group VIII, wherein the first metal element includes Fe and Co, wherein the second metal element is at least one selected from the group consisting of the metal elements of the Group IA and/or IIA, wherein the third metal element is at least one selected from the group consisting of the non-noble metal elements of the Groups IB to VIIB, and wherein the fourth metal element is at least one selected from the group consisting of the noble metal elements, and

wherein the precursor of the first metal element comprises precursor of Fe and precursor of Co in an amount so that the obtained catalyst comprises, on an oxide basis, Fe and Co in a weight ratio of 1 : (0.05-20),

wherein the structured monolithic carrier is selected from a monolithic carrier with parallel channels opened at both ends;

wherein the substrate is at least one selected from the group consisting of alumina, silica-alumina, zeolite, spinel, kaolin, diatomite, perlite and perovskite; and

wherein the first calcining and the second calcining are independently performed under a carbon-containing atmosphere at a temperature of 400-1000 ℃ for 0.1-10h; and

wherein at least part of Fe in the catalyst is presented in a form of iron carbide, and at least part of Co in the composition is presented in a form of elemental cobalt.

9. The method of claim 8, wherein the first calcining and the second calcining are independently performed under a carbon-containing atmosphere at a temperature of 400-1000 ℃, preferably 450-650 ℃, for 0.1-10h, preferably 1-3h;

preferably, the carbon-containing atmosphere is provided by a carbon-element-containing gas; preferably, the carbon-element-containing gas is at least one selected from the group consisting of CO, methane and ethane, more preferably is CO;

preferably, the volume concentration of CO in the carbon-containing atmosphere is 1-20%, preferably4-10%.

10. The method of claim 8 or 9, wherein, in the obtained catalyst, based on the total weight of the catalyst, the coating of active components is presented in an amount of 10-50 wt%, preferably 15-40 wt%, further preferably 20-35 wt%,

preferably, the source of the substrate, the precursor of the first metal element, the precursor of the second metal element, the precursor of the third metal element and the precursor of the fourth metal element are used in amounts such that in the obtained catalyst, based on the total weight of the coating of the active components, the source of the substrate is in an amount of 10-90% by weight, and on an oxide basis, the first metal element is in an amount of

0.5-50% by weight, the second metal element is in an amount of 0.5-20% by weight, the third metal element is in an amount of 0.5-20% by weight, and on an element basis, the fourth metal element is in an amount of 0.001-0.15% by weight; preferably, based on the total weight of the coating of the active components, the source of the substrate is in an amount of 50-90% by weight, and on an oxide basis, the first metal element is in an amount of 3-30% by weight, the second metal element is in an amount of 1-20% by weight, the third metal element is in an amount of 1-10% by weight, and on an element basis, the fourth metal element is in an amount of 0.005-0.1% by weight; further preferably, based on the total weight of the coating of the active components, the source of the substrate is in an amount of 55-85% by weight, and on an oxide basis, the first metal element is in an amount of 5-25% by weight, the second metal element is in an amount of 5-15% by weight, the third metal element is in an amount of 2-8% by weight, and on an element basis, the fourth metal element is in an amount of 0.01-0.08% by weight.

11. The method of any one of claims 8-10, wherein， precursor of Fe and precursor of Co are in an amount so that the obtained catalyst comprises, on an oxide basis, Fe and Co in a weight ratio of 1:(0.1-10), preferably 1:(0.3-3), further preferably 1:(0.5-2).

12. The method of any one of claims 8-11, wherein, the second metal element is at least one selected from the group consisting of Na, K, Mg and Ca, preferably K and/or Mg, most preferably Mg;

the third metal element is at least one selected from the group consisting of Cu, Zn, Ti, Zr, V, Cr, Mo, W, Mn and rare earth elements, preferably at least one selected from the group consisting of Zr, V, W, Mn, Ce and La, most preferably Mn;

the fourth metal element is at least one selected from the group consisting of Pt, Ir, Pd, Ru and Rh, most preferably Ru;

the precursor of the first metal element, the precursor of the second metal element, the precursor of the third metal element and the precursor of the fourth metal element are selected respectively from water-soluble salts of the first metal element, the second metal element, the third metal element and the fourth metal element.

13. The method of any one of claims 8-12, wherein, the precursor of the substrate in the first scheme is a material from which the substrate is obtainable under the conditions of the first calcining in step (2); and the precursor of the substrate in the second scheme is a material from which the substrate is obtainable under the conditions of the second calcining in step b) and/or the third calcining in step c);

the substrate is at least one selected from the group consisting of alumina, spinel and perovskite, and further preferably alumina;

preferably, the structured monolithic carrier has a pore density in the cross section of 20-900 pores/square inch and an opening rate in the cross section of 20-80%;

preferably, the structured monolithic carrier is at least one selected from the group consisting of a cordierite honeycomb carrier, a a mullite honeycomb carrier, a diamond honeycomb carrier, a corundum honeycomb carrier, a zirconium corundum honeycomb carrier, a quartz honeycomb carrier, a nepheline honeycomb carrier, a feldspar honeycomb carrier, an alumina honeycomb carrier and a metal alloy honeycomb carrier.

14. Use of the structured monolithic catalyst for reducing NOx emission in flue gas of any one of claims 1-7 in treating an incomplete regeneration flue gas from catalytic cracking process.

15. A method for treating an incomplete regeneration flue gas, comprising the step of contacting the incomplete regeneration flue gas with a catalyst, wherein the catalyst is the structured monolithic catalyst for reducing NOx emission in flue gas of any one of claims

1-7;

preferably, the contacting is carried out in a CO boiler and/or a flue gas channel before the CO boiler, more preferably the contacting is carried out in a flue gas channel before the CO incinerato;

preferably, the conditions of the contacting include at a temperature of 600-1000 ℃, a pressure of 0-0.5 MPa (gauge pressure), and a mass space velocity of flue gas of 100-1500h^{-1}.