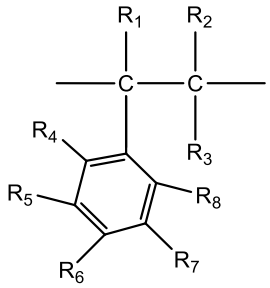
Claims

1. A catalyst for addition reaction of alkylene oxide, comprising a nanocomposite ion-exchange resin having a structural formula of P-Im^+-M^-, wherein P is a nanocomposite resin matrix, Im^+ is a cation derived from 5-6 membered heterocycle containing at least one nitrogen atom such as imidazolium cation, pyrazolium cation, pyrrolidinium cation, piperidinium cation, piperazinium cation, pyrimidinium cation, pyrazinium cation, pyridazinium cation, triazinium cation (for example a cation derived from 5-6 membered heteroarene containing at least one nitrogen atom, such as imidazolium cation, pyrazolium cation, pyrimidinium cation, pyrazinium cation, pyridazinium cation, triazinium cation), M^- is an anion; wherein the nanocomposite resin matrix P contains a polyhedral oligomeric silsesquioxane (POSS), which has a general formula of (-SiO1.5)m, and m is 6, 8, 10, or 12, and the mass content of POSS in the nanocomposite resin matrix P is 0.1-10%.

2. The catalyst according to claim 1, which is characterized in that the nanocomposite resin matrix comprises a structure fragment represented by formula I and a structure fragment of-CH(POSS)-CH_2-,

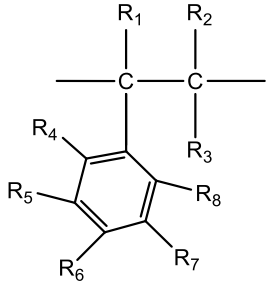


Formula I

In formula I, R_1-R_8 are identical to or different from each other, and each independently selected from hydrogen and C_1-C_6 alkyl, preferably selected from hydrogen, methyl, ethyl, propyl, and butyl;

POSS is a polyhedral oligomeric silsesquioxane, which has a general formula of (-SiO1.5)m, and m is 6, 8, 10, or 12.

3. The catalyst according to any of the preceding claims, which is characterized in that the catalyst comprises the following structure:



Wherein R_1-R_3 are identical to or different from each other, and each independently

selected from hydrogen and C_1-C_6 alkyl;

R_4-R_8 are each independently selected from hydrogen, C_1-C_6 alkyl, and CH_2Im^+-M^-, and at least one of R_4-R_8 is CH_2Im^+-M^-, preferably, R_4-R_8 are each independently selected from hydrogen and CH_2Im^+-M^-, and at least one of R_4-R_8 is CH_2Im^+-M^-.

4. The catalyst according to any of the preceding claims, which is characterized in that said M^- is one or more of halide ions and organic acid radical ions, preferably one or more of a fluoride ion, a chloride ion, a bromide ion, an iodide ion, an acetate group, a formate group, and a bioxalate group;

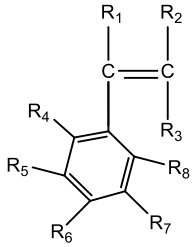
and/or, the mass content of POSS in the nanocomposite resin matrix P is 0.2-5%, preferably 2-5%.

5. A process for preparing a catalyst as claimed in any of claims 1-4, comprising the following steps:

S1: polymerizing a styrene-based monomer, a cross-linking agent, and a polyhedral oligomeric silsesquioxane in the presence of an initiator to obtain a nanocomposite resin matrix P;

S2: subjecting the nanocomposite resin matrix P obtained in step S1 to a chloromethylation reaction, an imidazolation reaction, and an ion-exchange reaction.

6. The process according to claim 5, which is characterized in that said styrene-based monomer is one or more of styrene-based monomers represented by formula II;



Formula II

In formula II, R_1-R_8 are identical to or different from each other, and each independently selected from hydrogen and C_1-C_6 alkyl, preferably selected from hydrogen, methyl, ethyl, propyl, and butyl;

and/or, said polyhedral oligomeric silsesquioxane is one or more of a vinyl-containing silsesquioxane, a hydrogen-containing polysilsesquioxane, an alkoxy-containing polysilsesquioxane, and an epoxy-containing polysilsesquioxane, preferably said vinyl-containing silsesquioxane is an octavinylsilsesquioxane;

and/or, said cross-linking agent is one or more of ethylene glycol bismethacrylate, dipropenylbenzene, divinylphenylmethane, and divinylbenzene;

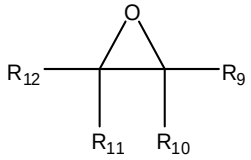
and/or, said initiator is at least one of benzoyl peroxide, azodiisobutyronitrile, azodiisoheptylonitrile, lauroyl peroxide, and cumene hydroperoxide,

and/or, in step S1, based on the total weight of raw materials, the mass of said styrene-based monomer is 85-95%, the mass of the cross-linking agent is 1-6%, the

mass of said polyhedral oligomeric silsesquioxane is 0.1-10%, preferably 0.2-5%, and more preferably 2-5%, and the mass of the initiator is 0.1-5%.

7. A method for an addition reaction of alkylene oxide and carbon dioxide, which comprises reacting alkylene oxide and carbon dioxide in the presence of the catalyst according to any of claims 1-4 or a catalyst prepared with the process according to claim 5 or 6.

8. The method according to claim 7, which is characterized in that the alkylene oxide has a general formula of



wherein, R_9-R_{12} are identical to or different from each other and each independently selected from hydrogen, C_1-C_6 alkyl, and C_6-C_{10} aryl, preferably selected from hydrogen, methyl, ethyl, propyl, butyl, and phenyl; and/or,

The mass ratio of the catalyst to the alkylene oxide is (0.001-1):1, preferably (0.1-0.3):1.

9. The method according to claim 7 or 8, which is characterized in that the reaction temperature is 60-180°C, preferably 100-160°C; and/or the reaction pressure is 0.1-10.0MPa, preferably 2-5MPa; and/or, the reaction time is 1-8 hours, preferably 3-6 hours.

10. Use of the catalyst according to any of claims 1-4 or a catalyst prepared with the process according to claim 5 or 6 in the addition reaction of alkylene oxide.