CLAIMS

1. An actively encapsulating liposome nanocarrier delivery system, characterized in that the liposome nanocarrier delivery system includes a liposome carrier and a substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease actively encapsulated by the liposome carrier.

2. The liposome nanocarrier delivery system according to claim 1, characterized in that materials of the liposome carrier comprise phospholipid and cholesterol;

alternatively, the phospholipid is one or more selected from the following: hydrogenated soybean phosphatidylcholine, distearoylphosphatidylcholine, distearoylphosphatidylethanolamine, polyethylene glycol-distearoylphosphatidylethanolamine, distearoylphosphatidylglycerol, distearoylphosphatidylserine, dioleoylphosphatidylcholine, dioleoylphosphatidylethanolamine, dioleoylphosphatidylserine, dioleoylphosphatidylethanolamine-polyethylene glycol, dicinnamoylphosphatidylcholine, dicinnamoylphosphatidylethanolamine, dicinnamoylphosphatidylserine, dicinnamoylphosphatidylethanolamine-polyethylene glycol, dipalmitoylphosphatidylcholine, dipalmitoylphosphatidylethanolamine, dipalmitoylphosphatidylserine, dipalmitoylphosphatidylethanolamine-polyethylene glycol, dierucoylphosphatidylcholine, dierucoylphosphatidylethanolamine, dierucylphosphatidylserine, dierucylphosphatidylethanolamine-polyethylene glycol, sphingomyelin, egg phosphatidylcholine, egg phosphatidylethanolamine, and egg phosphatidylglycerol.

3. The liposome nanocarrier delivery system according to claim 1 or 2, characterized in that the mass ratio of the substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease to the liposome carrier is 1:0.1 to 50, alternatively 1:0.2 to 30, yet alternatively 1:0.5 to 20.

4. The liposome nanocarrier delivery system according to any one of claims 1-3, characterized in that the substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease is a weakly acidic substance;

yet alternatively, the substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease is one or more selected from the following: statins, fibrates, antiplatelet drugs, PCSK9 inhibitors, anticoagulant drugs, angiotensin converting enzyme inhibitors, calcium ion antagonists, MMPs inhibitors, β-receptor blockers, glucocorticoid, and pharmaceutically acceptable salts thereof, and active formulations of the drugs or substances;

yet alternatively, the substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease is one or more selected from the following: lovastatin, atorvastatin, rosuvastatin, simvastatin, fluvastatin, pitavastatin, pravastatin, bezafibrate, ciprofibrate, gemfibrozil, aspirin, acemetacin, sodium ozagrel, beraprost sodium, tirofiban, and pharmacodynamic fragments or pharmaceutically acceptable salts thereof;

still alternatively, the substance used for preventing and/or treating atherosclerosis or an atherosclerosis-related disease is water-soluble statins, alternatively rosuvastatin, pravastatin or atorvastatin.

5. The liposome nanocarrier delivery system according to any one of claims 1-4, characterized in that the liposome nanocarrier delivery system can be modified with a targeting ligand,

alternatively, the targeting ligand is one or more selected from the following: GAG, collagen, laminin, fibronectin, selectin, osteopontin (OPN), monoclonal antibodies HI44a, HI313, A3D8, H90 and IM7, and hyaluronic acid or a derivative of hyaluronic acid.

6. The liposome nanocarrier delivery system according to any one of claims 1-5, characterized in that the liposome carrier is selected from small unilamellar liposomes, large unilamellar

liposomes or multilamellar liposomes.

7. A method for preparing the liposome nanocarrier delivery system according to any one of claims 1-6, including a step of hydrating the liposome carrier by adding a salt solution and performing separation to form a solution acidity gradient between inside and outside of the liposomes.

8. The method for preparing the liposome nanocarrier delivery system according to claim 7, characterized in that the salt is a salt of weak acid and strong alkali;

alternatively, the anionic portion of the salt is one or more selected from the following:

acetate, edetate, bicarbonate, hypochlorite, citrate, benzoate and gluconate; and/or

the cationic portion of the salt is one or more selected from the following: calcium ions, copper ions, nickel ions, barium ions, magnesium ions and zinc ions;

yet alternatively, the salt is one or more selected from the following: calcium acetate, calcium bicarbonate, magnesium citrate and copper gluconate.

9. The method for preparing the liposome nanocarrier delivery system according to claim 7 or 8, characterized in that the method comprises the following steps:

(1) dissolving the liposome carrier material in a good solvent;

(2) adding a salt solution that forms a solution acidity gradient between inside and outside of the liposomes to the product obtained in step (1) to hydrate and disperse it into a crude lipid solution;

(3) reducing the particle size of the crude lipid solution obtained in step (2) to obtain refined

liposomes;

(4) purifying the refined liposome solution obtained in step (3) to remove external ions, and forming an acidity gradient between inside and outside of the liposomes; and

(5) adding a solution of the substance to be encapsulated to the liposome solution obtained in step (4), and performing incubation to allow the drug to enter the interior of the liposomes to obtain the liposome nanocarrier delivery system.

10. The method according to claim 9, characterized in that

i) the step (1) further comprises a step of removing the solvent by evaporation to make the liposomes form a lipid membrane;

alternatively, the evaporation temperature is 40-80°C, alternatively 50-70°C, yet alternatively 50-60°C;

yet alternatively, the evaporation method is rotary evaporation; and

still alternatively, the rotary evaporation is performed at a speed of 50-200 r/min, alternatively 70-120 r/min, yet alternatively 80-100 r/min; and/or

ii) in step (1), the good solvent is one or more selected from the following: chloroform, ethanol, methanol, methylene chloride, acetone, toluene, diethyl ether, ethyl acetate, methyl acetate, acetonitrile, and dichloroethane.

11. The method according to any one of claims 9-10, characterized in that in step (1), the materials of the liposome carrier comprise phospholipid and cholesterol;

alternatively, the phospholipid is at a concentration of 0.1-500 mg/mL, alternatively 0.1-200 mg/mL, yet alternatively 0.2-100 mg/mL; and/or

the cholesterol is at a concentration of 0.05-200 mg/mL, alternatively 0.1-100 mg/mL, yet alternatively 0.1-50 mg/mL.

12. The method according to any one of claims 9-11, characterized in that in step (2), the salt solution has a concentration of 100-500 mM, alternatively 200-300 mM, yet alternatively 200-250 mM; and/or

the hydration temperature is 30-90°C, alternatively 40-80°C, yet alternatively 45-65°C.

13. The method according to any one of claims 9-12, characterized in that in step (3), the method for reducing the particle size is extruding the crude lipid solution through a filter membrane;

alternatively, the filter membrane is a polycarbonate membrane;

yet alternatively, the filter membrane has a pore size of 30-800 nm, such as 50-400 nm, such as 100-200 nm, such as 30 nm, 50 nm, 100 nm, 200 nm, 400 nm, 600 nm or 800 nm, alternatively 100-150 nm.

14. The method according to any one of claims 9-13, characterized in that in step (4), the method for removing external ions is one or more selected from the following: separation through an ultrafiltration membrane pack, dialysis separation and ion exchange.

15. The method according to any one of claims 9-14, characterized in that in step (5), the solution of the substance to be encapsulated is at a concentration of 0.01-100 mg/mL, alternatively 0.05-50 mg/mL, yet alternatively 0.1-20 mg/mL, still alternatively 0.1-10 mg/mL.

16. The method according to any one of claims 9-15, characterized in that in step (5), the incubation temperature is 20-80°C, alternatively 40-70°C, yet alternatively 55-65°C.

17. The method according to any one of claims 9-16, characterized in that when the liposome nanocarrier delivery system is modified with a targeting ligand, the method further comprises the following step:

(6) co-incubating the targeting ligand with the liposome nanocarrier delivery system obtained in step (5) to obtain a modified liposome nanocarrier delivery system.

18. A medicine, characterized in that the medicine comprises the nanocarrier delivery system according to any one of claims 1-6 or the nanocarrier delivery system prepared by the method according to any one of claims 7-17, and a pharmaceutically acceptable carrier.

19. Use of the nanocarrier delivery system according to any one of claims 1-6, the nanocarrier delivery system prepared by the method according to any one of claims 7-17, or the medicine according to claim 18 in the manufacture of a medicament for preventing and/or treating atherosclerosis or an atherosclerosis-related disease;

wherein alternatively, the atherosclerosis-related disease is one or more selected from the following: atherosclerosis, coronary atherosclerotic heart disease (including acute coronary syndrome, asymptomatic myocardial ischemia—latent coronary heart disease, angina pectoris, myocardial infarction, ischemic heart disease, sudden death, and in-stent restenosis), cerebral atherosclerosis (including cerebral ischemic stroke and hemorrhagic apoplexy), peripheral vascular atherosclerosis (including carotid atherosclerosis, vertebral atherosclerosis, subclavian atherosclerosis, occlusive peripheral atherosclerosis, retinal atherosclerosis, renal atherosclerosis, lower extremity atherosclerosis, upper extremity atherosclerosis, mesenteric atherosclerosis and atherosclerotic impotence), aortic dissection, hemangioma, thromboembolism, heart failure, and cardiogenic shock.

20. Use of the nanocarrier delivery system according to any one of claims 1-6, the nanocarrier delivery system prepared by the method according to any one of claims 7-17, or the medicine

according to claim 18 in the manufacture of a medicament for treating vascular plaques;

alternatively, the vascular plaques are arterial plaques;

yet alternatively, the medicament is used to curb the progression of arterial plaques, reverse arterial plaques and/or reduce the volume of arterial plaques.