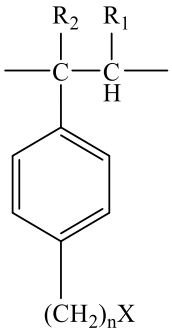
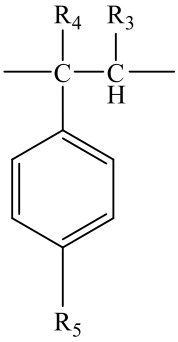
# Claims

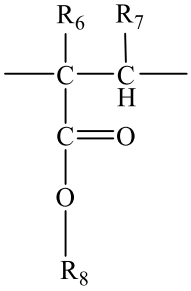
1. A multi-component copolymer comprising a structural unit A, a structural unit B, and a structural unit C, wherein the structural unit A has a structure represented by formula (1), the structural unit B has a structure represented by formula (2), and the structural unit C has a structure represented by formula (3);




Formula (1),




Formula (2),




Formula (3)

wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen or a $C_1$-$C_{10}$ linear chain or branched alkyl; X is halogen, and n is any integer of 1 to 10;

the tail end of the multi-component copolymer contains a structural unit from a conjugated diene.

2. The multi-component copolymer according to claim 1, wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen or a $C_1$-$C_6$ linear chain or branched alkyl;

and/or, X is selected from Cl and/or Br;

and/or, n is any integer of 1 to 5;

and/or, the conjugated diene is butadiene and/or isoprene;

and/or, the mass ratio of structural unit A, structural unit B, structural unit C, and the structural unit from a conjugated diene is 100: (20-50): (10-25): (1-5);

and/or, the mass percentage content of halogen in the multi-component copolymer is within the range of 2.5-5.5%.

3. The multi-component copolymer according to claim 2, wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen or a $C_1$-$C_4$ linear chain or branched alkyl;

and/or, n is any integer of 1 to 3;

and/or, the mass ratio of structural unit A, structural unit B, structural unit C, and the structural unit from a conjugated diene is 100: (30-40): (15-20): (2-3);

and/or, the mass percentage content of halogen in the multi-component copolymer is within the range of 4-5%.

4. The multi-component copolymer according to claim 3, wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen, methyl, or ethyl.

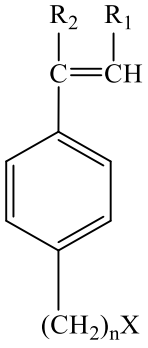
5. The multi-component copolymer according to claim 1, wherein $R_6$ is methyl.

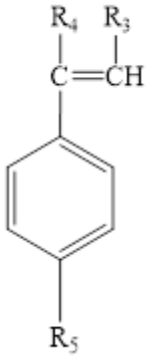
6. The multi-component copolymer according to claim 1 or 2, wherein the multi-component copolymer has a number average molecular weight within the range of 25,000-60,000 g/mol;

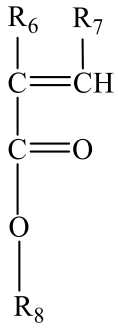
and/or, the multi-component copolymer has a molecular weight distribution index within the range of 1.2-2;

and/or, the multi-component copolymer has an apparent viscosity within the range of 8-40cps at 25°C.

7. A method for preparing a multi-component copolymer comprising: subjecting a monomer represented by formula (I), a monomer represented by formula (II), and a monomer represented by formula (III) to a polymerization reaction under a polymerization reaction conditions and in the presence of an initiator, an optional structural modifier, and an organic solvent to obtain a polymer solution;



Formula (I),


Formula (II),


Formula (III)

adding a conjugated diene monomer into the polymer solution to carry out an end-capping reaction to prepare the multi-component copolymer;

wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen or a $C_1$-$C_{10}$ linear chain or branched alkyl; X is halogen, and n is any integer of 1 to 10.

8. The method according to claim 7, wherein $R_1$, $R_2$, $R_3$, $R_4$, $R_5$, $R_6$, $R_7$ and $R_8$ are each independently hydrogen or a $C_1$-$C_6$ linear chain or branched alkyl;

and/or, X is selected from Cl and/or Br;

and/or, n is any integer of 1 to 5.

9. The method according to claim 7, wherein the conjugated diene is butadiene and/or isoprene;

and/or, the mass ratio of the monomer represented by formula (I), the monomer represented by formula (II), the monomer represented by formula (III), and the conjugated diene is 100: (20-50) : (10-25) : (1-5);

and/or, the polymerization reaction is carried out under a protective atmosphere;

and/or ,the initiator is a hydrocarbon-based monolithium compound;

and/or, the initiator is used in an amount of 16-30mmo1 relative to 1,000g of the monomer represented by formula (I);

and/or, the structural modifier is a polar organic compound;

and/or, the organic solvent is a hydrocarbon solvent.

10. The method according to claim 7, wherein the polymerization reaction conditions comprise: the polymerization reaction temperature is within the range of 50-80°C, and the polymerization reaction time is within the range of 220-270 min;

and/or, the end-capping reaction temperature is within the range of 60-90°C, and the end-capping reaction time is within the range of 10-45 min.

11. The method according to claim 7, wherein the method further comprises:

(1) mixing a monomer represented by formula (I), a structural modifier, an organic solvent, and an initiator to perform a first polymerization reaction to obtain a first polymerization product;

(2) adding a monomer represented by formula (II) and a structural modifier into the first polymerization product, then mixing the materials to perform a second polymerization reaction to obtain a second polymerization product;

(3) adding a monomer represented by formula (III) and a structural modifier into the second polymerization product, then mixing the materials to perform a third polymerization reaction to obtain a third polymerization product;

(4) adding a conjugated diene into the third polymerization product to

perform an end-capping reaction to prepare the multi-component copolymer;

and/or, wherein the mass ratio of the monomer represented by formula (I) to the structural modifier in step (1) is 100: (0.5-0.7);

and/or, the mass ratio of the monomer represented by formula (II) to the structural modifier in step (2) is (30-40) : (0.3-0.5);

and/or, the mass ratio of the monomer represented by formula (III) to the structural modifier in step (3) is (15-20) : (0.2-0.3);

and/or, the first polymerization reaction temperature is within the range of 40-80°C, and the first polymerization reaction time is within the range of 80-150 min;

and/or, the second polymerization reaction temperature is within the range of 60-90°C, and the second polymerization reaction time is within the range of 50-80 min;

and/or, the third polymerization reaction temperature is within the range of 60-90°C, and the third polymerization reaction time is within the range of 30-60 min.

12. A multi-component copolymer produced with the method according to any one of claims 7-11.

13. A use of the multi-component copolymer according to any one of

claims 1-6 and 12 as a grating agent in the preparation of the diene rubber.

14. The use according to claim 13, wherein the diene rubber is butyl rubber.

15. A halogenated branched butyl rubber comprising a structural unit I from isobutylene, a structural unit II from isoprene, and a structural unit III from halogenated grafting agent;
wherein the halogenated grafting agent is the multi-component copolymer according to any one of claims 1-6 or 12.

16. The halogenated branched butyl rubber according to claim 15, wherein the mass ratio of said structural unit I, said structural unit II, and said structural unit III is 100: (4-6) : (7-10), based on the total weight of the halogenated branched butyl rubber.

17. A method for preparing a halogenated branched butyl rubber according to claim 15 or 16 comprising:
contacting isobutylene and isoprene with the multi-component copolymer according to any one of claims 1-6 and 12 in the presence of a diluent, an organic solvent, and a co-initiator for performing the cationic polymerization to prepared the halogenated branched butyl rubber.

18. The method according to claim 17, wherein the mass ratio of isobutylene, isoprene, and multi-component copolymer is 100: (4-6) : (7-10);

and/or, the diluent is a halogenated alkane;

and/or, the diluent is at least one selected from the group consisting of methane chloride, methylene chloride, carbon tetrachloride, dichloroethane, tetrachloropropane, heptachloropropane, fluoromethane, difluoromethane, tetrafluoroethane, carbon hexafluoride, and fluorobutane;

and/or, the mass ratio of said isobutene to said diluent is 100: (180-320);

and/or, the organic solvent is a hydrocarbon solvent;

and/or, the co-initiator comprises an alkyl aluminum halide and a protic acid;

and/or, the molar ratio of said alkyl aluminum halide to said protic acid in the co-initiator is (10-100) : 1;

and/or, the alkyl aluminum halide is at least one selected from the group consisting of diethyl aluminum monochloride, diisobutyl aluminum monochloride, methyl aluminum dichloride, ethyl aluminum sesquichloride, isobutyl aluminum sesquichloride, n-propyl aluminum dichloride, isopropyl aluminum dichloride, dimethyl aluminum chloride, and ethyl aluminum chloride;

and/or, the protonic acid is at least one selected from the group consisting of HCl, HF, HBr, $H_2SO_4$, $H_2CO_3$, $H_3PO_4$ and $HNO_3$;

and/or the mass ratio of said isobutene to said co-initiator is 100 : (0.1-0.3); and/or, the cationic polymerization conditions comprise: the cationic polymerization temperature from -100°C to -75°C; and the cationic polymerization time within the range of 3-4 h.

19. A halogenated branched butyl rubber produced with the method according to any one of claims 17or 18.

20. A use of the halogenated branched butyl rubber according to any one of claims 15, 16, and 19 in instrument shock absorbers and electric appliance vibration absorbers.