Claims:

1. Copolymers of isobutylene and isoprene having a copolymer sequence distribution defined by equation (I)

$$F = mA / (1 + mA)^2 \quad \text{(eq. I)}$$

wherein

- A is the molar ratio of isoprene to isobutylene in the copolymer as determined by ^1H NMR; and
- F is the isoolefin-isoprene-isoprene triad fraction in the copolymer as determined by ^{13}C NMR;

and wherein m is in the range of

$$[1{,}30 - (0.025 \times MOC)] \geq m \geq [1{,}15 - (0.025 \times MOC)]$$

whereby MOC is the content of isoprene in the copolymer in mol-% as determined by ^1H NMR; and the isobutylene content is from 90.0 to 91.0 mol.-% and the isoprene content is from 9.0 to 10.0 mol.-%.

2. The copolymers according to claim 1, wherein m is in the range of

$$[1{,}28 - (0.025 \times MOC)] \geq m \geq [1{,}16 - (0.025 \times MOC)]$$

or

$$[1{,}27 - (0.025 \times MOC)] \geq m \geq [1{,}17 - (0.025 \times MOC)].$$

3. Halogenated copolymers according to claim 1 or 2.

4. The halogenated copolymers according to claim 3, wherein the amount of halogen of such halogenated copolymers is in the range of from 0.1 to 8.0 wt.-%, preferably in the range of from 0.5 to 4 wt.-%, more preferably from 0.8 wt.-% to 3 wt.-%, even more preferably in the range of from 1.2 to 2,5 wt.-%, even still more preferably of from 1.5 wt.-% to 2.5% and most preferably of from 1.8 to 2.3 wt.-% by weight of the halogenated copolymer.

5. A process for the preparation of copolymers of isobutylene and isoprene having a copolymer sequence distribution defined by equation (I)

$$F = mA / (1 + mA)^2 \quad \text{(eq. I)}$$

wherein

- A is the molar ratio of isoprene to isobutylene in the copolymer as determined by ^1H NMR; and
- F is the isoolefin-isoprene-isoprene triad fraction in the copolymer as determined by ^{13}C NMR;

and wherein m is in the range of

$$[1{,}30 - (0.025 \times MOC)] \geq m \geq [1{,}15 - (0.025 \times MOC)]$$

whereby MOC is the content of isoprene in the copolymer in mol-% as determined by ^1H NMR,

the process comprising at least, preferably exclusively the steps of:

a) providing a diluent and a monomer mixture comprising isobutylene and isoprene in a mass ratio of monomer mixture to diluent of from 5:95 to 95:5, preferably from 40:60 to 95:5, more preferably from 45:55 to 85:15 and even more preferably from 61:39 to 80:20 to form a reaction medium;

b) polymerizing the monomer mixture within the reaction medium in the presence of an initiator system comprising ethyl aluminum sesquichloride to form a copolymer solution comprising the copolymer which is at least substantially dissolved in the reaction medium comprising the diluent and residual monomers of the monomer mixture;

c) separating residual monomers of the monomer mixture and preferably additionally the diluent from the reaction medium to obtain the copolymer

whereby step b) is carried out

- at a temperature in the range of -95 °C to -60 °C, preferably in the range of -85 °C to -60 °C and even more preferably in the range of -82 °C to -68 °C,

  and whereby the diluent

- comprises at least 95.0 wt.-%, preferably at least 98.0 wt.-%, more preferably at least 98.5 wt.-% and even more preferably at least 99.0 wt.-% of one or more aliphatic hydrocarbons having a boiling point in the range of 5 °C to 95 °C at a pressure of 1013 hPa and
- comprises at maximum 1.0 wt.-%, preferably less than 0.8 wt.-%, more preferably less than 0.5 wt.-% and even more preferably less than 0.2 wt.-% of halogenated, in particular fluorinated or chlorinated or fluorinated and chlorinated hydrocarbons and is most preferably free of such halogenated hydrocarbons.

6. The process according to claim 5, wherein m is in the range of

$$[1{,}28 - (0.025 \times MOC)] \geq m \geq [1{,}16 - (0.025 \times MOC)]$$

or

$$[1{,}27 - (0.025 \times MOC)] \geq m \geq [1{,}17 - (0.025 \times MOC)].$$

7. The process according to claim 5 or 6, wherein the isobutylene content is from 85.0 to 99.5 mol.-% and the isoprene content is from 0.5 to 15.0 mol.-%, preferably the isobutylene content is from 88.0 to 99.0 mol.-% and the isoprene content is from 1.0 to 12.0 mol.-%.

8. The process according to anyone of claims 5 to 7, wherein the isobutylene content is from 86.2 to 99.5 mol.-% and the isoprene content is from 0.5 to 3.8 mol.-%, preferably the isobutylene content is from 86.3 to 99.0 mol.-% and the isoprene content is from 1.0 to 3.7 mol.-%.

9. The process according to anyone of claims 5 to 8, wherein for the diluent the content of aliphatic hydrocarbons having a boiling point in the range of 5 °C to 95 °C at a pressure of 1013 hPa and being linear (n-alkanes) does not exceed 85 wt.-%, preferably does not exceed 70 wt.-%, more preferably 50 wt.-% and is yet even more preferably in range of from 10 to 50 wt.-%.

10. The process according to anyone of claims 5 to 9, wherein for the diluent the content of cyclic hydrocarbons having a boiling point in the range of 5 °C to 95 °C at a pressure of

1013 hPa does not exceed 25 wt.-%, preferably does not exceed 20 wt.-% and is even more preferably in range of from 1 to 20 wt.-%.

11. The process according to anyone of claims 5 to 10, wherein the initiator system comprises ethyl aluminum sesquichloride generated by mixing equimolar amounts of diethyl aluminum chloride and ethyl aluminum dichloride, preferably in a diluent.

12. The process according to anyone of claims 5 to 11, wherein for the initiator system water and/or alcohols, preferably water is used as proton source.

13. A process for the preparation of halogenated copolymers according to claims 3 or 4, the process comprising at least the steps of

    - a) and b) of the process according to anyone of claims 5 to 12 and
    - c) separating residual monomers of the monomer mixture
    - d) halogenation

14. The process according to claim 13, wherein halogenation is carried out using elemental chlorine (Cl_2) or bromine (Br_2) as halogenation agent.

15. A polymer product comprising the copolymers according to claim 1 or 2 and/or the halogenated copolymers according to claims 3 or 4 either cured or uncured.