CLAIMS

1. Process for producing an ethylene-1-octene copolymer in a continuous high temperature solution process at a temperature from 120°C to 250°C and a pressure of 50 to 300 bar, the process comprising at least the steps of:

(A) polymerizing in at least a first polymerization reactor in a first solvent ethylene monomer and 1-octene comonomer in the presence of a first polymerization catalyst and optionally a chain transfer agent for producing a first solution comprising a first ethylene-1-octene copolymer and the first solvent;

whereby the first solvent, ethylene monomer and 1-octene comonomer are provided in a first feed stream; and

wherein the first polymerization reactor is operated under operating conditions which ensure that the reactor contents form a single homogenous phase,

(B) withdrawing a first stream of the first solution from the first polymerization reactor,

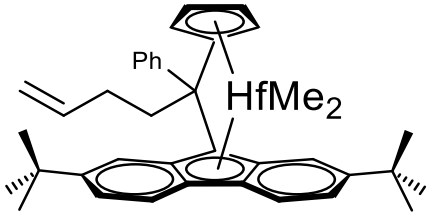
(C) separating the first ethylene-1-octene copolymer from the first stream of step (B),

wherein the first polymerization catalyst comprises:

(i) at least one metallocene complex of formula (I)

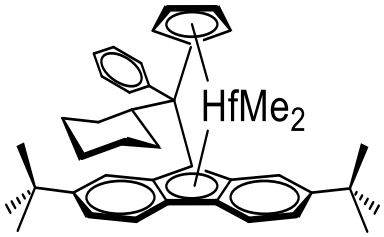
(ii) a boron containing cocatalyst,

wherein the at least one metallocene complex of formula (I) is a metallocene complex of formula (Ia)



(Ia)

and/or a metallocene complex of formula (Ib)



(Ib),

the ethylene-1-octene copolymer having

a) a density in the range of 850 kg/m^3 to 930 kg/m^3 measured according to ISO 1183-187,
b) a melt flow rate MFR_2 (190°C, 2.16 kg) in the range of from 0.8 g/10 min to 100 g/10 min measured according to ISO 1133,
c) a MFR_{10}/MFR_2 of from 5.0 to 15.0 measured according to ISO 1133,
d) a Mw/Mn of from 2.0 to 5.0 determined by Gel Permeation Chromatography,
e) 1.0 to below 20.0 vinyl unsaturation units /100,000 C atoms measured by 1H NMR,
f) more than 5.0 to 35.0 vinylidene unsaturation units /100,000 C atoms measured by 1H NMR,
g) more than 5.0 to 30.0 vinylene unsaturation units /100,000 C atoms measured by 1H NMR,
h) more than 15.0 to 60.0 trisubstituted unsaturation units / 100,000 C atoms measured by 1H NMR,
i) 26 to 150 total unsaturation units /100,000 C atoms, wherein the total unsaturation units /100,000 C atoms is the sum of vinyl unsaturation units /100,000 C atoms, vinylidene unsaturation units /100,000 C atoms, vinylene unsaturation units /100,000 C atoms and trisubstituted unsaturation units /100,000 C atoms, all measured by 1H NMR,
j) an unsaturation degree according to formula

$$unsaturation_{Type}\ degree\ (\%) = \frac{unsaturation_{Type}\ units\ /\ 100{,}000\ C\ atoms}{total\ unsaturation\ units/100{,}000\ C\ atoms} * 100$$

wherein

a vinyl unsaturation degree is in the range of from 5.0 to 20 %,

a vinylene unsaturation degree is in the range of from 12.0 to 30.0 %, and

k) wherein the sum of the vinyl unsaturation degree and vinylidene unsaturation degree is at least 30.0% up to 50.0%.

2. The process according to claim 1, wherein the total unsaturation units/100,000 C of the copolymer follows the inequation (I)

$$y > -0.0002A + 65.8 \quad (I)$$

wherein y is the total unsaturation /100 000 C atoms and A is the Mw of the copolymer in g/mol,

and/or the total unsaturation units/100,000 C of the copolymer follows the inequation (II)

$$y > 0.12B + 39.38 \quad (II)$$

wherein y is the total unsaturation /100 000 C atoms and B is the 1-octene content of the copolymer in wt.%.

3. The process according to claim 1 or 2, wherein the ratio MFR10/MFR2 is in a range of from 6.0 to 13.0 measured according to ISO 1133.

4. The process according to any one of the preceding claims, wherein the Mw/Mn is in the range of 2.4 up to 4.0 determined by Gel Permeation Chromatography.

5. The process according to any one of the preceding claims, wherein the melt flow rate MFR_2 (190°C, 2.16 kg) is in the range of from 0.8 g/10 min to 90 g/10 min measured according to ISO 1133.

6. The process according to any one of the preceding claims, wherein a vinylidene unsaturation degree is in the range of from 20.0 to 32.0 % and/or a trisubstituted unsaturation degree is in the range of from 35.0 to 50.0 %.

7. The process according to any one of the preceding claims, wherein the vinyl unsaturation degree is in the range of from 7.0 to 17.0 %, and/or wherein the vinylidene unsaturation degree is in the range of from 22.0 to 28.0 %, and/or wherein the vinylene unsaturation degree is in the range of from 14.0 to 28.0 %, and/or wherein the trisubstituted unsaturation degree is in the range of from 36.0 to 45.5 %.

8. The process according to any one of the preceding claims, wherein the 1-octene is present in an amount of 10 to 45 wt.% based on the weight of the total copolymer.

9. The process according to any one of the preceding claims, further comprising the steps of

(D) polymerizing in a second polymerization reactor in a second solvent ethylene monomer and 1-octene comonomer in the presence of a second polymerization catalyst and optionally a chain transfer agent for producing a second solution comprising a second ethylene-1-octene copolymer and the second solvent;

whereby the second solvent, ethylene monomer and 1-octene comonomer are provided in a second feed stream; and

wherein the second polymerization reactor is operated under operating conditions which ensure that the reactor contents form a single homogenous phase,

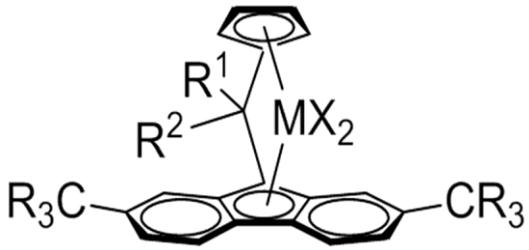
(E) withdrawing a second stream of the second solution from the second polymerization reactor,

(F) separating the second ethylene-1-octene copolymer from the second stream of step (E), and

(G) combining the first ethylene-1-octene copolymer of step (C) with the second ethylene-1-octene copolymer of step (F),

wherein the second polymerization catalyst comprises:

(i) at least one metallocene complex of formula (I)



wherein

M is Hafnium,

R are the same or different from each other and can be a saturated linear or branched C1 to C10 alkyl, preferably all R are the same and are a linear or branched C1 to C3 alkyl, more preferably all R are a C1 alkyl group,

R^1 is a unsubstituted C6 to C10 aryl, preferably phenyl and

R^2 is a C4 to C20 cycloalkyl group or a C4 to C6 alkenyl groups,

X is a C1 to C6 alkyl, preferably methyl, and

(ii) a boron containing cocatalyst, and

wherein the first polymerization catalyst and the second polymerization catalyst can be the same or different from each other.

10. The process according to any one of the preceding claims, wherein a comonomer reactivity according to formula (II)

$$\text{Comonomer Reactivity} = (C8/C2)_{polymer} / (C8/C2)_{feed} \quad (II)$$

is > 0.28 up to 0.65,

wherein in the formula (II)

$(C8/C2)_{polymer}$ is the ratio of wt.% of 1-octene/wt.% of ethylene in the copolymer and

$(C8/C2)_{feed}$ is the ratio of wt.% of 1-octene/wt.% of ethylene in the first feed stream, or in the sum of first feed stream and the second feed

stream.

11. The process according to any one of the preceding claims, wherein the boron containing cocatalyst comprises an anion of formula (III)

$$(Z)_4B^-\quad (III)$$

wherein Z is an optionally substituted phenyl derivative, said substituent being a halo-C_{1-6}-alkyl or halo group.

12. The process according to any one of the preceding claims, wherein the boron containing cocatalyst is a borate selected from the group comprising

triphenylcarbeniumtetrakis(pentafluorophen-yl)borate,

N,N- imethylcyclohexylammoniumtetrakis(pentafluorophenyl)borate,

N,N- dimethylbenzylammoniumtetrakis(pentafluorophenyl)borate or

N,N-dimethylaniliniumtetrakis(pentafluorophenyl)borate.

13. Ethylene-1-octene copolymer obtained by a process according to any one of claims 1 to 12.