phenylporphyrin and 66.5 g dichloromethane. Oxygen (1.5 Nl/h) is bubbled through the reaction mixture while it is irradiated at 20 °C. After 120 min the reaction is terminated. After evaporation of the solvent the reaction mixture is analysed by NMR spectroscopy.

Taking into account the thus described reactivity an overall reactivity of mixtures of polyisobutene isomers in thermal respectively photoreactions can be calculated which serves as the basis for the present invention.

In *Macromolecules*, **2011,** 44(7), pages 1831-1840, "Mechanism of Isomerization in the Cationic Polymerization", R. Faust et al. disclose DFT calculations regarding the relative stability of different polyisobutene isomers.

While the tetra-substitued isomer (C4) is lowest in energy, another tetra-substitued isomer (C3) has an energy content of just 2.63 kJ/mol higher. In contrast the isomer (A) with an alpha-double bond is 30.46 kJ/mol higher and the isomer (B) which is desired according to the present invention is even 33.98 kJ/mol higher (for the designation of the isomers see below).

Hence, among these four isomers the desired isomer (B) is highest in energy and, therefore, under thermodynamic control of the reaction conditions expected to be formed least in equilibrium.

It is known that reactivity of the different double bond isomers in polyisobutene depends on the molecular weight. The reactivity of double bond isomers may be different in low, medium or high molecular weight polyisobutene. For example, it is known from WO 2017/216022, see e.g. Example 3, that under reaction conditions which lead to good yields of maleinated product for low molecular polyisobutene only minor amounts of product can be obtained if higher molecular weight polyisobutene is used. When using higher molecular weight polyisobutene a much higher stochiometry of maleic acid anhydride, higher reaction temperatures and/or longer reaction times are necessary to achieve comparable yields.

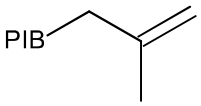
In an aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of at least 50%,

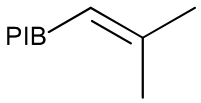
calculated according to formula
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

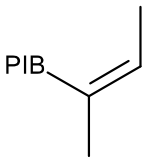
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



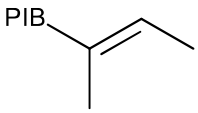
-- (A) bearing an alpha-double bond,



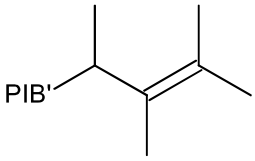
-- (B) bearing a beta-double bond,



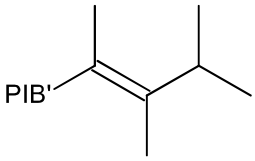
(C1)



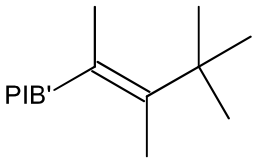
(C2)



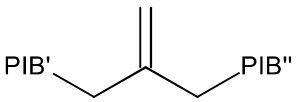
(C3)



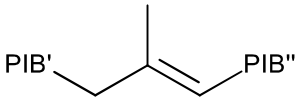
(C4)



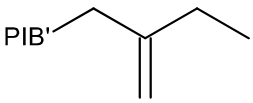
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

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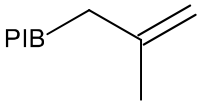
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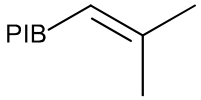
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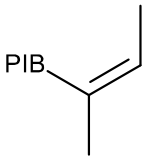
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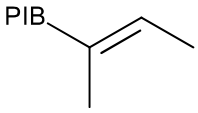
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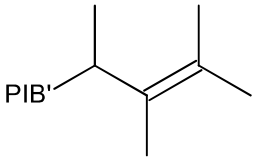
-- (B) bearing a beta-double bond,



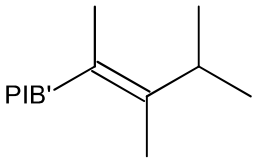
(C1)



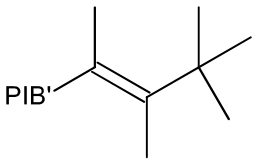
(C2)



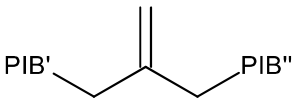
(C3)



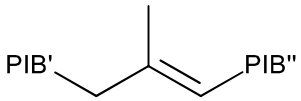
(C4)



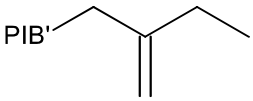
(C5)



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In another aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

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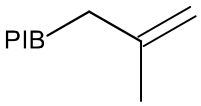
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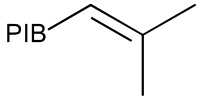
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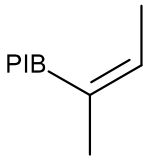
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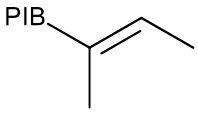
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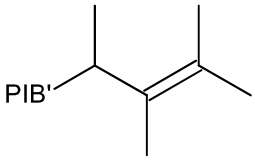
-- (B) bearing a beta-double bond,



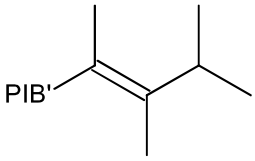
(C1)



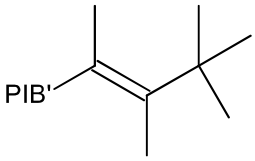
(C2)



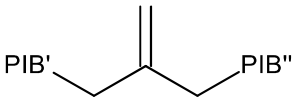
(C3)



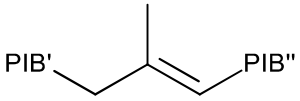
(C4)



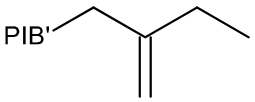
(C5)



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(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

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spectroscopy after evaporation of the solvent.

In another aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition
obtained by polymerisation of isobutene or an isobutenic starting material in the presence of at least one Lewis Acid-donor complex and an initiator,
wherein the Lewis Acid is a halide of boron, aluminium, iron, gallium, titanium, zinc or tin

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

calculated according to formulae

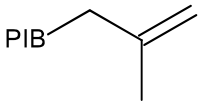
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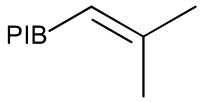
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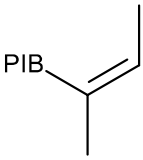
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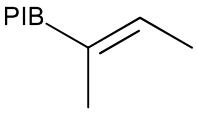
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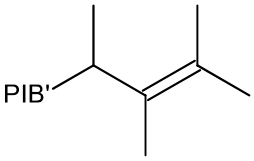
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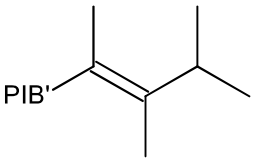
(C1)



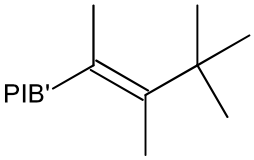
(C2)



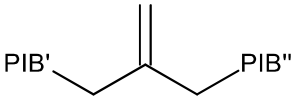
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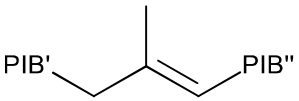
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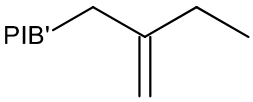
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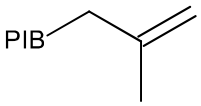
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

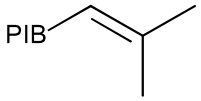
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

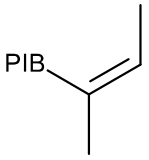
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



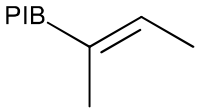
-- (A) bearing an alpha-double bond,



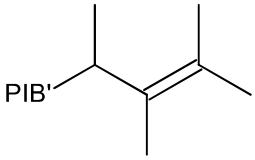
-- (B) bearing a beta-double bond,



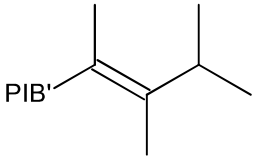
(C1)



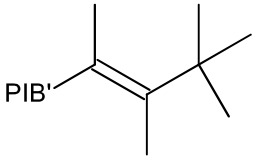
(C2)



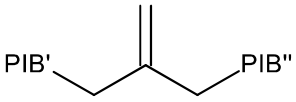
(C3)



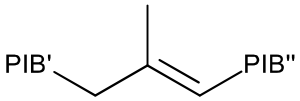
(C4)



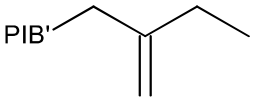
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer (A) is more than 60%,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

In another aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

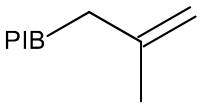
calculated according to formulae
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

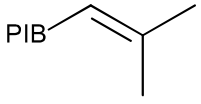
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

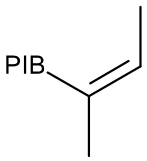
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



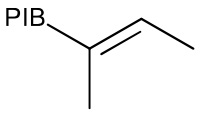
-- (A) bearing an alpha-double bond,



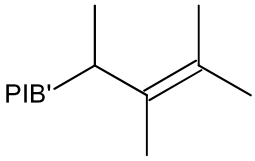
-- (B) bearing a beta-double bond,



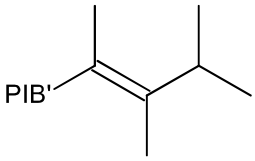
(C1)



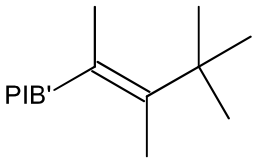
(C2)



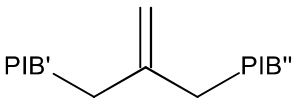
(C3)



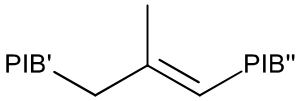
(C4)



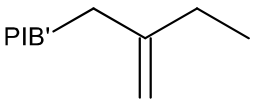
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer (B) is more than 50%,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of

the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

In another aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

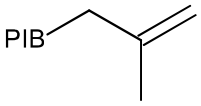
calculated according to formulae
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

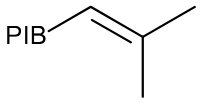
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

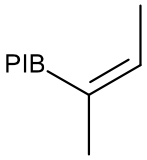
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



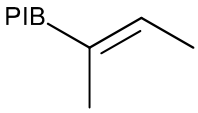
-- (A) bearing an alpha-double bond,



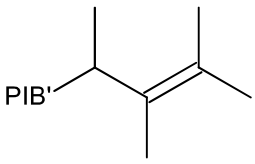
-- (B) bearing a beta-double bond,



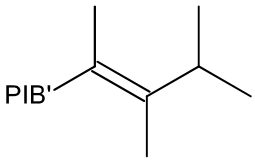
(C1)



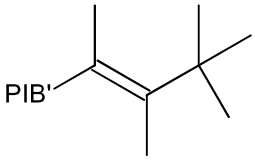
(C2)



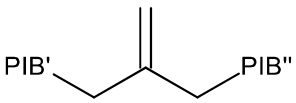
(C3)



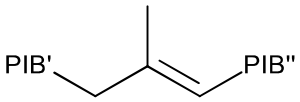
(C4)



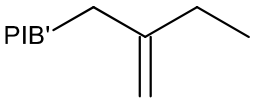
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

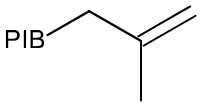
with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer [(C6)+(C8)] (in sum) is more than 20%,

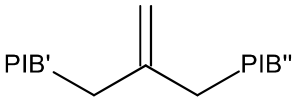
wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

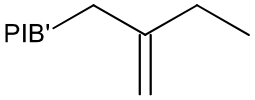
In another aspect, there is provided a medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition, comprising
- at least 45 to not more than 90 mol% (in sum) of polyisobutene species selected from the group consisting of



-- (A) bearing an alpha-double bond,



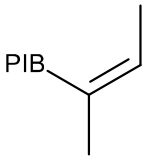
-- (C6) , and



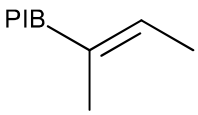
-- (C8) ,

- up to 10 mol% polyisobutene species (B) bearing a beta-double bond,
- up to 10 mol% (in sum) polyisobutene isomers (C1) + (C2) + (C7),

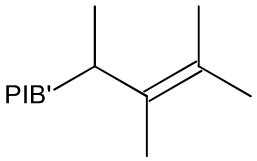
selected from the group consisting of



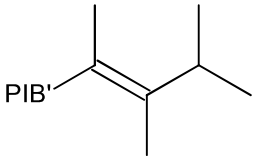
(C1)



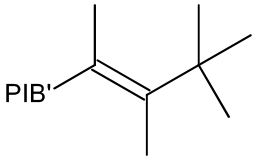
(C2)



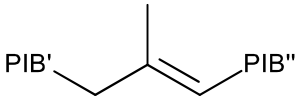
(C3)



(C4)



(C5)

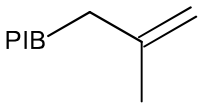


(C7)

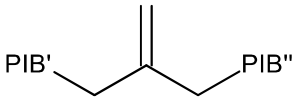
in which PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,
wherein at least one of the isomers (C1), (C2), (C6), (C7), and (C8) is present,

wherein the sum of (A), (B), and (C) always adds up to 100 mol%.

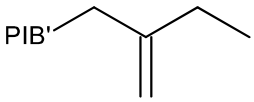
1. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition, comprising
- not more than 10 mol% (in sum) of at least one polyisobutene species selected from the group consisting of



-- (A) bearing an alpha-double bond,

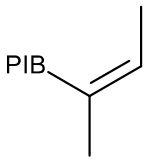


-- (C6) , and

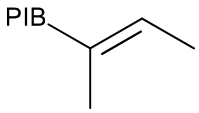


-- (C8) ,
- at least 30 up to 55 mol% polyisobutene species (B) bearing a beta-double bond,
- up to 10 mol% (in sum) polyisobutene isomers (C1) + (C2) + (C7),

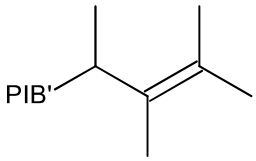
selected from the group consisting of



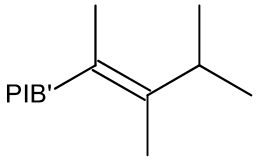
(C1)



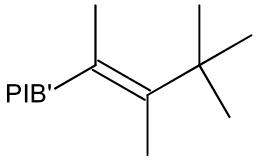
(C2)



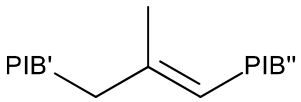
(C3)



(C4)



(C5)



(C7)

in which PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,
wherein at least one of the isomers (C1), (C2), (C6), (C7), and (C8) is present,

wherein the sum of (A), (B), and (C) always adds up to 100 mol%.

In another aspect, there is provided a process for preparation of compositions as defined above, comprising the steps of
- choosing as a starting material a medium molecular polyisobutene composition with a content of polyisobutene species (A) bearing an alpha-double bond of at least 30 mol%, preferably at least 40, more preferably at least 50 mol%,
- optionally at least one solvent,
- optionally at least one initiator, preferably water or at least one organic hydroxyl compound, and more preferably water
- treating the optionally dissolved polyisobutene composition
-- in the presence of at least one acidic solid state catalyst, optionally treated with at least one Brønsted-base
-- for a period of from 10 minutes to 36 hours
-- at a temperature of from 40 °C to 250 °C.

In another aspect, there is provided the use of compositions as defined above in reactions to obtain further derivatives, preferably in oxidation reactions, more preferably in photo oxygenations.

In another aspect, there is provided the use of compositions as defined above in reactions thermal chemical reactions, especially epoxidation, hydroformylation, and ene-reaction with maleic anhydride.

In another aspect, there is provided the use of compositions as defined above in sealants, adhesives, coatings or roofings.

In another aspect, there is provided the use of compositions as defined above in chewing gums or plasters.

It has been found that medium molecular polyisobutene comprises a mixture of different isomers with a different position and configuration of the double bond:

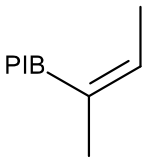
isomers (A) bearing an alpha-double bond,

isomers (B) bearing a beta-double bond

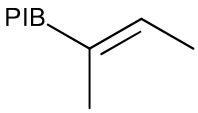
and polyisobutene isomers (C) other than (A) and (B),

selected from the group consisting of

3o



(C1)



(C2)

Claims

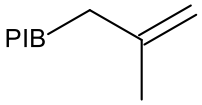
1. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of at least 50%,

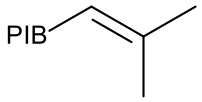
calculated according to formula
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

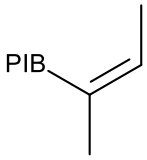
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



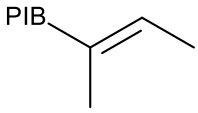
-- (A) bearing an alpha-double bond,



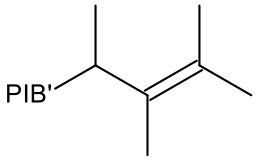
-- (B) bearing a beta-double bond,



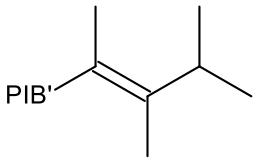
(C1)



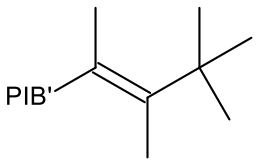
(C2)



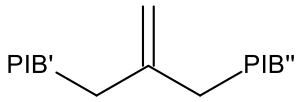
(C3)



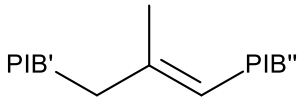
(C4)



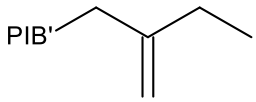
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy.

2. Medium molecular polyisobutene according to Claim 1 wherein the content
- of isomer (A) is more than 60%.

3. Medium molecular polyisobutene according to Claim 1 wherein the content
- of isomer (B) is more than 50%.

4. Medium molecular polyisobutene according to Claim 1 wherein the content
- of isomer [(C6)+(C8)] (in sum) is more than 20%.

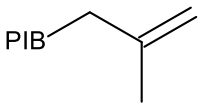
5. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in photo oxygenations R_{po} of at least 49%,

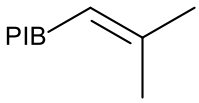
calculated according to formula
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

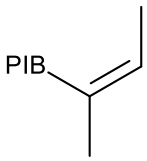
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



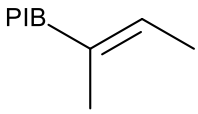
-- (A) bearing an alpha-double bond,



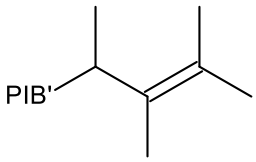
-- (B) bearing a beta-double bond,



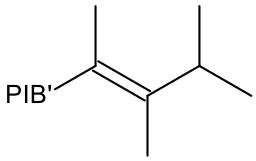
(C1)



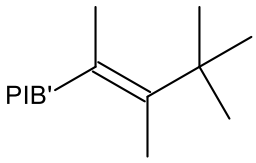
(C2)



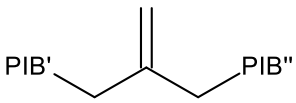
(C3)



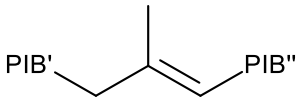
(C4)



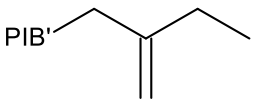
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C1) and (C2) are present in the composition,

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR

spectroscopy after evaporation of the solvent.

6. Medium molecular polyisobutene according to Claim 5 wherein the content - of isomer (A) is more than 60%.

7. Medium molecular polyisobutene according to Claim 5 wherein the content - of isomer (B) is more than 50%.

8. Medium molecular polyisobutene according to Claim 5 wherein the content - of isomer [(C6)+(C8)] (in sum) is more than 20%.

9. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of at least 40% and in photo oxygenation R_{po} of at least 49%,

calculated according to formulae

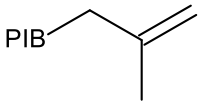
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

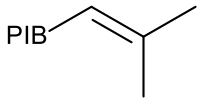
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

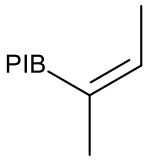
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



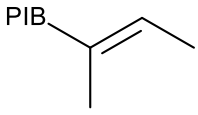
-- (A) bearing an alpha-double bond,



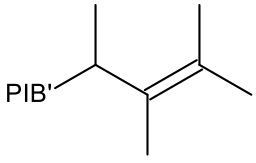
-- (B) bearing a beta-double bond,



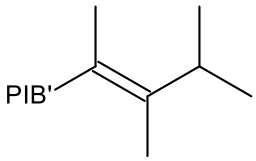
(C1)



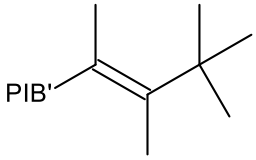
(C2)



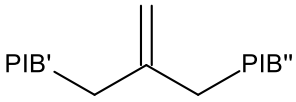
(C3)



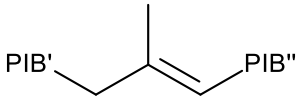
(C4)



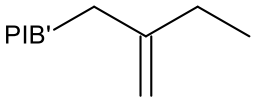
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C1), (C2), (C6) and (C8) are present in the composition,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

10. Medium molecular polyisobutene according to Claim 9 wherein the content
- of isomer (A) is more than 60%.

11. Medium molecular polyisobutene according to Claim 9 wherein the content
- of isomer (B) is more than 50%.

12. Medium molecular polyisobutene according to Claim 9 wherein the content
- of isomer [(C6)+(C8)] (in sum) is more than 20%.

13. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition
obtained by polymerisation of isobutene or an isobutenic starting material in the presence of at least one Lewis Acid-donor complex and an initiator,
wherein the Lewis Acid is a halide of boron, aluminium, iron, gallium, titanium, zinc or tin

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

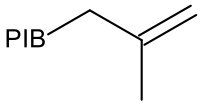
calculated according to formulae
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

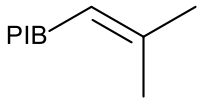
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

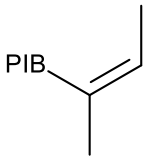
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



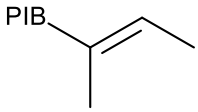
-- (A) bearing an alpha-double bond,



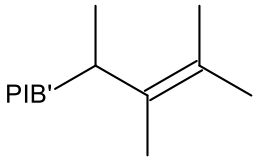
-- (B) bearing a beta-double bond,



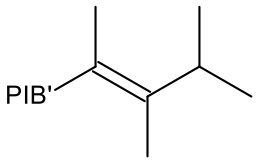
(C1)



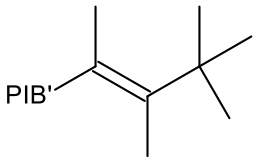
(C2)



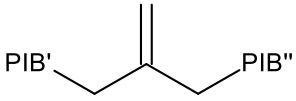
(C3)



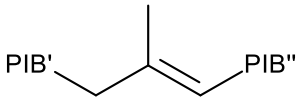
(C4)



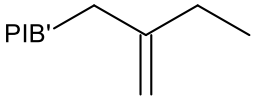
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent..

14. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

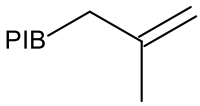
calculated according to formulae
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

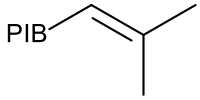
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

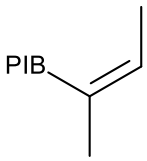
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



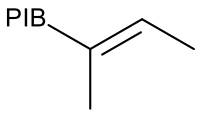
-- (A) bearing an alpha-double bond,



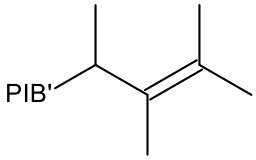
-- (B) bearing a beta-double bond,



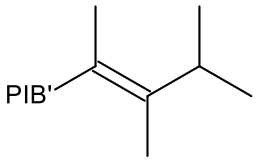
(C1)



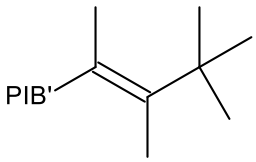
(C2)



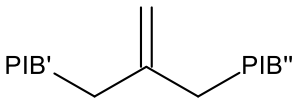
(C3)



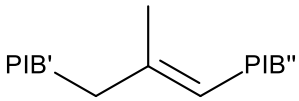
(C4)



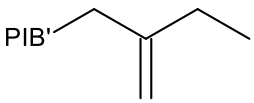
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer (A) is more than 60%,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

15. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

calculated according to formulae

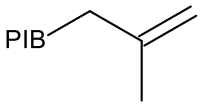
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

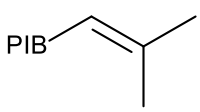
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

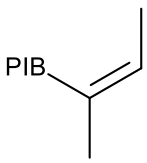
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



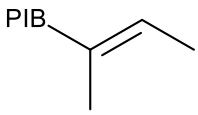
-- (A) bearing an alpha-double bond,



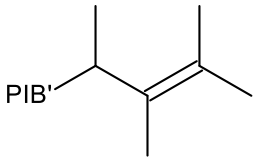
-- (B) bearing a beta-double bond,



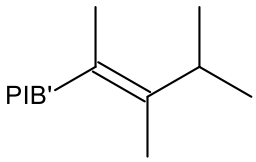
(C1)



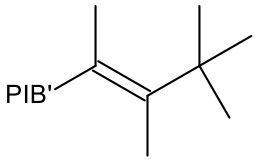
(C2)



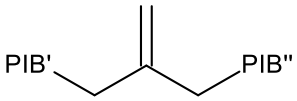
(C3)



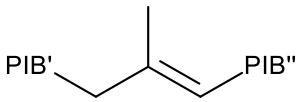
(C4)



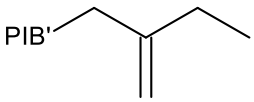
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer (B) is more than 50%,

wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor,

equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

16. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition

with a reactivity in thermal reactions R_{tr} of not more than 40% and in photo oxygenation R_{po} of not more than 49%,

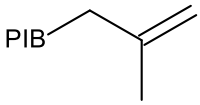
calculated according to formulae
R_{tr} = 100% * [A] + 79% * ([C6]+ [C8]) + 37% * ([B]+ [C7]) + 11% * ([C1]+ [C2])

and

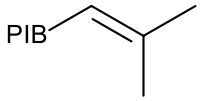
R_{po} = 37% * [A] + 21% * ([C6]+ [C8]) + 100% * ([B]+ [C7]) + 95% * ([C1]+ [C2])

wherein the letters refer to the isomers and the squared brackets refer to the content of the respective isomer in mol% in the polyisobutene composition,

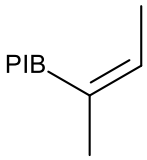
wherein the composition comprises at least one polyisobutene species selected from the group consisting of



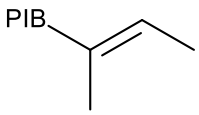
-- (A) bearing an alpha-double bond,



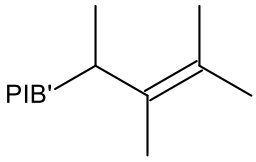
-- (B) bearing a beta-double bond,



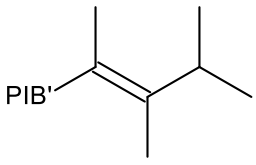
(C1)



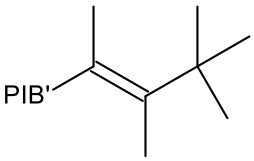
(C2)



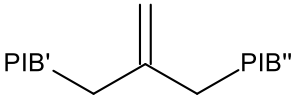
(C3)



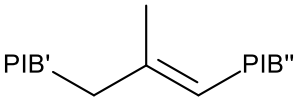
(C4)



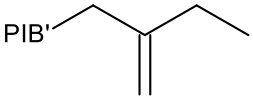
(C5)



-- (C6) ,



(C7) , and



-- (C8) ,

in which PIB, PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,

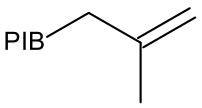
with the proviso that (A), (B), and at least one of (C6) and (C8) are present in the composition,

wherein the content
- of isomer [(C6)+(C8)] (in sum) is more than 20%,

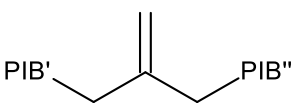
wherein the reactivity in thermal reactions R_{tr} is determined by stirring 50,0 g of polyisobutene with an approx. Mn of 17000 g/ in a 250 ml pressure reactor under nitrogen blanket with 4.3 g maleic acid anhydride for 7 hours at 230 °C, after the end of the reaction cooling to 120 °C within 30 minutes, diluting with 200 ml xylene and removing from the reactor at 120 °C, followed by further dilution with 300 ml heptane, filtering of the solution, solvent removal in vacuo and determination of the composition of the reaction mixture by 1H-NMR spectroscopy, and

wherein the reactivity in photo oxygenations R_{po} is determined by irradiation at 20 °C for 120 min of 10.0 g polyisobutene with an approx. Mn of 17000 g/mol, 2.5 mg tetraphenylporphyrin and 66.5 g dichloromethane in a photochemical batch reactor, equipped with eighty-eight 405 nm LEDs and analysis of the reaction mixture by NMR spectroscopy after evaporation of the solvent.

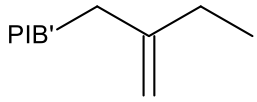
17. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition, comprising
- at least 45 to not more than 90 mol% (in sum) of polyisobutene species selected from the group consisting of



-- (A) bearing an alpha-double bond,



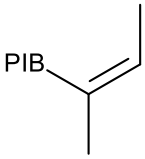
-- (C6) , and



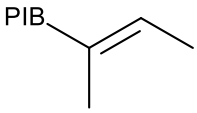
-- (C8) ,

- up to 10 mol% polyisobutene species (B) bearing a beta-double bond,
- up to 10 mol% (in sum) polyisobutene isomers (C1) + (C2) + (C7),

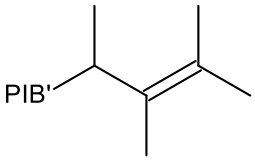
selected from the group consisting of



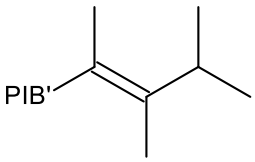
(C1)



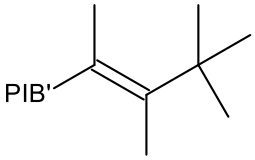
(C2)



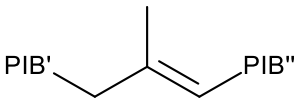
(C3)



(C4)



(C5)

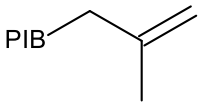


(C7)

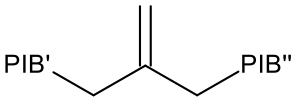
in which PIB' and PIB'' refer to appropriately shortened polymeric backbones of the polyisobutene,
wherein at least one of the isomers (C1), (C2), (C6), (C7), and (C8) is present,

wherein the sum of (A), (B), and (C) always adds up to 100 mol%.

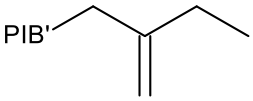
18. Medium molecular polyisobutene with a number-average molecular weight M_n (determined by gel permeation chromatography) of more than 10000 g/mol containing composition, comprising
- not more than 10 mol% (in sum) of at least one polyisobutene species selected from the group consisting of



-- (A) bearing an alpha-double bond,



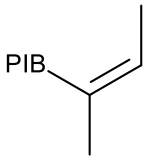
-- (C6) , and



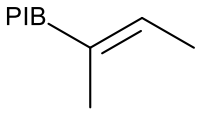
-- (C8) ,

- at least 30 up to 55 mol% polyisobutene species (B) bearing a beta-double bond,
- up to 10 mol% (in sum) polyisobutene isomers (C1) + (C2) + (C7),

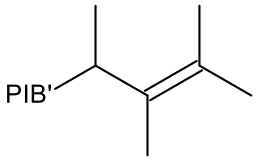
selected from the group consisting of



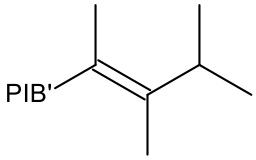
(C1)



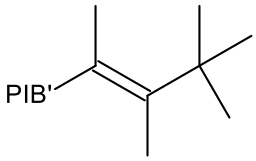
(C2)



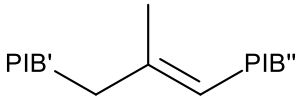
(C3)



(C4)



(C5)



(C7)

in which PIB' and PIB" refer to appropriately shortened polymeric backbones of the polyisobutene,
wherein at least one of the isomers (C1), (C2), (C6), (C7), and (C8) is present,

wherein the sum of (A), (B), and (C) always adds up to 100 mol%.

19. Compositions according to any one of preceding Claims, wherein the content of n-hexane is not more than 1000 ppm by weight, preferably not more than 900, more preferably not more than 800, and especially not more than 750 ppm by weight, and simultaneously the content of isobutene is not more than 50 ppm by weight, preferably not more than 40, more preferably not more than 30, especially not more than 25 ppm, and even not more than 20 ppm by weight.

20. Compositions according to any one of Claims 1 to 19, wherein the polydispersity is from 1.2 to 10, preferably from 1.3 to 9, more preferably from 1.4 to 8, even more preferably from 1.5 to 6 and especially from 2 to 5.

21. Process for preparation of compositions according to any of Claims 5 or 18, comprising the steps of
- choosing as a starting material a medium molecular polyisobutene composition with a content of polyisobutene species (A) bearing an alpha-double bond of at least 30 mol%, preferably at least 40, more preferably at least 50 mol%,
- optionally at least one solvent,
- optionally at least one initiator, preferably water or at least one organic hydroxyl compound, and more preferably water
- treating the optionally dissolved polyisobutene composition
-- in the presence of at least one acidic solid state catalyst, optionally treated with at least one Brønsted-base
-- for a period of from 10 minutes to 36 hours
-- at a temperature of from 40 °C to 250 °C.

22. Use of compositions according to any one of Claims 5, 9 or 18 in reactions to obtain further derivatives, preferably in oxidation reactions, more preferably in photo oxygenations.

23. Use of compositions according to any of Claims 1 or 13 in reactions thermal chemical reactions, especially epoxidation, hydroformylation, and ene-reaction with maleic anhydride.

24. Use of compositions according to Claim 13 in sealants, adhesives, coatings or roofings.

25. Use of compositions according to Claim 19 in chewing gums or plasters.