group introduced with the living cationic polymerization has to be eliminated in a separate step in order to generate the double bond.

It has additionally been known for some time that the Lewis acid aluminum trichloride can also be used as a polymerization catalyst for isobutene, for example from High Polymers, volume XXIV (part 2), p. 713-733 (editor: Edward C. Leonard), J. Wiley & Sons publishers, New York, 1971.

In the literature article "Cationic polymerization using heteropolyacid salt catalysts" in Topics in Catalysis Vol. 23, p. 175-181 (2003), James D. Burrington et al. indicate that, with aluminum trichloride as a polymerization catalyst for isobutene, only low-reactivity polyisobutenes with a low content of terminal vinylidene double bonds (α-double bonds) can be obtained. For instance, table 1 on page 178 of this literature article cites an example of a polyisobutene prepared with $AlCl_3$, which has a number-average molecular weight M_n of 1000-2000, a polydispersity M_w/M_n of 2.5-3.5 and a content of vinylidene isomer (α-double bond) of only 5% (in addition to 65% "tri", 5% "β" and 25% "tetra").

In the literature article "Novel initiating system based on $AlCl_3$ etherate for quasiliving cationic polymerization of styrene" in Polymer Bulletin Vol. 52, p. 227-234 (2004), Sergei V. Kostjuk et al. describe a catalyst system composed of 2-phenyl-2-propanol and an aluminum trichloride/di-n-butyl ether complex for polymerization of styrene. The polydispersities M_w/M_n of the styrene polymers thus prepared are "~2.5" (see summary) or "~3" (see page 230).

WO 11/101281 disclose the preparation of highly reactive polyisobutene polymers by polymerizing a monomer mixture containing isobutene in the presence of an aluminum trihalogenide donor complex acting as a polymerization catalyst. The donor complex comprises an organic compound having at least one ether function or a carboxylic acid function as the donor.

Dmitriy I. Shiman, Irina V. Vasilenko, Sergei V. Kostjuk, Journal of Polymer Science, Part A: Polymer Chemistry 2014, 52, 2386–2393 disclose the preparation of polyisobutene polymers by polymerizing isobutene in the presence of an alkylaluminum halogenide an ether complex as a polymerization catalyst.

It was an object of the embodiments disclosed herein to provide a process for preparing high-reactivity isobutene homo- or copolymers with an increased content of terminal vinylidene double bonds per polyisobutene chain end of at least 70 mol% and simultaneously with a narrow molecular weight distribution (i.e. low polydispersities) in acceptable yields. The catalyst system should at the same time have sufficient activity and service life, the handling thereof should be unproblematic and it should not be prone to failure.

The object was achieved by a process for preparing high-reactivity isobutene homo- or copolymers with a content of terminal vinylidene double bonds per polyisobutene chain end of at least

70, preferably at least 75 and very preferably at least 80 mol%, which comprises polymerizing isobutene or an isobutene-comprising monomer mixture in the presence of an aluminum trihalide-donor complex effective as a polymerization catalyst or of an alkylaluminum halide-donor complex, said complex comprising, as the donor, a mixture of at least two organic compounds with at least one ether function each.

In an aspect, there is provided a process for preparing high-reactivity isobutene homo- or copolymers with a content of terminal vinylidene double bonds per polyisobutene chain end of at least 70 mol%, which comprises polymerizing isobutene or an isobutene-comprising monomer mixture in the presence of an aluminum trihalide-donor complex effective as a polymerization catalyst or of an alkylaluminum halide-donor complex, said complex comprising, as the donor, a mixture of at least two organic compounds with at least one ether function each.

Isobutene homopolymers are understood in the context of the present invention to mean those polymers which, based on the polymer, are formed from isobutene to an extent of at least 98 mol%, preferably to an extent of at least 99 mol%. Accordingly, isobutene copolymers are understood to mean those polymers which comprise less than 2 mol%, preferably less than 1 mol%, very preferably less than 0.7 mol% and especially less than 0.5 mol% of copolymerized monomers other than isobutene, for example isoprene or linear butenes, preferably 1-butene, cis-2-butene, and trans-2-butene.

In the context of the present invention, the following definitions apply to generically defined radicals:

A C_1- to C_8-alkyl radical is a linear or branched alkyl radical having 1 to 8 carbon atoms. Examples thereof are methyl, ethyl, n-propyl, isopropyl, n-butyl, 2-butyl, isobutyl, tert-butyl, pentyl, 1-methylbutyl, 2-methylbutyl, 3-methylbutyl, 2,2-dimethyl-propyl, 1-ethylpropyl, n-hexyl, 1,1-dimethylpropyl, 1,2-dimethylpropyl, 1-methylpentyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 1,1-dimethylbutyl, 1,2-dimethylbutyl, 1,3-dimethylbutyl, 2,2-dimethylbutyl, 2,3-dimethylbutyl, 3,3-dimethylbutyl, 1-ethylbutyl, 2-ethylbutyl, 1,1,2-trimethylpropyl, 1,2,2-trimethylpropyl, 1-ethyl-1-methylpropyl, 1-ethyl-2-methylpropyl, n-heptyl, n-octyl and the constitutional isomers thereof, such as 2-ethylhexyl. Such C_1- to C_8-alkyl radicals may to a small extent also comprise heteroatoms such as oxygen, nitrogen or halogen atoms, for example chlorine, and/or aprotic functional groups, for example carboxyl ester groups, cyano groups or nitro groups.

A C_1- to C_{20}-alkyl radical is a linear or branched alkyl radical having 1 to 20 carbon atoms. Examples thereof are the abovementioned C_1- to C_8-alkyl radicals, and additionally n-nonyl, isononyl, n-decyl, 2-propylheptyl, n-undecyl, n-dodecyl, n-tridecyl, isotridecyl, n-tetradecyl, n-hexadecyl, n-octadecyl and n-eicosyl. Such C_1- to C_{20}-alkyl radicals may to a small extent also comprise heteroatoms such as oxygen, nitrogen or halogen atoms, for example chlorine, and/or aprotic functional groups, for example carboxyl ester groups, cyano groups or nitro groups.

A C_5- to C_8-cycloalkyl radical is a saturated cyclic radical which may comprise alkyl side chains. Examples thereof are cyclopentyl, 2- or 3-methylcyclopentyl, 2,3-, 2,4- or 2,5-dimethylcyclopentyl, cyclohexyl, 2-, 3- or 4-methylcyclohexyl, 2,3-, 2,4-, 2,5-, 2,6-, 3,4-, 3,5- or 3,6-dimethylcyclohexyl, cycloheptyl, 2-, 3- or 4-methylcycloheptyl, cyclooctyl, 2-, 3-, 4- or 5-methylcyclooctyl. Such C_5- to C_8-cycloalkyl radicals may to a small extent also comprise het