

Summary

[0008] Examples may be realized by providing a method of producing a polyether polyol that includes reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, and the low molecular weight initiator has a nominal hydroxyl functionality at least 2. The one or more monomers including at least one selected from propylene oxide and butylene oxide. The polymerization catalyst is a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group or a first fluoro/chloro-substituted phenyl group, R^3 includes a third fluoroalkyl-substituted phenyl group or a second fluoro/chloro-substituted phenyl group, and optional R^4 includes a functional group or functional polymer group, R^1 being different from at least one of R^2 and R^3 . The method further includes forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

[0008a] In one aspect, the present disclosure refers to a method of producing a polyether polyol, comprising: reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group that is the same as the first fluoroalkyl-substituted phenyl group, R^3 includes a second fluoro/chloro-substituted phenyl group or a third fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof; and forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

[0008b] In another aspect, the present disclosure refers to a method of producing a polyether polyol, comprising: reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group, R^3 includes a third fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group and the second fluoroalkyl-substituted phenyl group, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof; and forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

[0008c] In another aspect, the present disclosure refers to a method of producing a polyether polyol, comprising: reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_1$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group or a first fluoro/chloro-substituted phenyl group, R^3 includes a third fluoroalkyl-substituted phenyl group or a second fluoro/chloro-substituted phenyl group, and R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof, R^1 being different from at least one of R^2 and R^3 ; and forming a polyether polyol

having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

[0008d] In another aspect, the present disclosure refers to a method of producing a polyurethane product, the method comprising: providing a polyether polyol produced according to the method as disclosed herein and providing an isocyanate.

Detailed Description

[0009] As discussed in International Publication No. WO 2012/091968, certain Lewis acids that may essentially require no activation time have been evaluated as polymerization catalysts. However, some Lewis acids may become deactivated rapidly and may not be capable of producing high molecular weight polymers or of obtaining high conversions of alkylene oxides to polymer. Further, high amounts of alkaline catalysts, such as sodium hydroxide may require treatment such as filtration and/or acid finishing/neutralization (e.g., as discussed in U.S. Patent No. 5,468,839) to reduce the base content of the resultant product. The use of a sufficiently low amount of Lewis acid catalysts and optionally a DMC catalyst may eliminate the need for such treatment, while also providing for control and/or selectivity. However, certain Lewis acids may promote undesirable side reactions. The presence of certain side products in a polyol product may necessitate performing an additional finishing step on the resultant product.

[0010] Embodiments relate to certain Lewis acid catalysts, and processes using such Lewis acid catalysts, that may provide advantages with respect to minimizing side reactions such as those that produce aldehydes and/or acetals, while still allowing for precise control of the polymerization reaction. Embodiments may relate to providing polyol polymers having a desirably low level of aldehydes and acetals. The polyols are derived from at least

Listing of the Claims:

1. A method of producing a polyether polyol, comprising:

reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group that is the same as the first fluoroalkyl-substituted phenyl group, R^3 includes a second fluoro/chloro-substituted phenyl group or a third fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof; and forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

2. A method of producing a polyether polyol, comprising:

reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group, R^3 includes a third fluoroalkyl-substituted phenyl group that is different from the first fluoroalkyl-substituted phenyl group and

the second fluoroalkyl-substituted phenyl group, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof; and

forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

3. A method of producing a polyether polyol, comprising:

reacting a low molecular weight initiator with one or more monomers in the presence of a polymerization catalyst, the low molecular weight initiator having a nominal hydroxyl functionality of at least 2 and a molecular weight of less than 5000 g/mol as measured by gel permeation chromatography, the one or more monomers being at least one selected from propylene oxide and butylene oxide, and the polymerization catalyst being a Lewis acid catalyst having the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_1$, whereas M is boron, aluminum, indium, bismuth or erbium, R^1 , R^2 , R^3 , and R^4 are each independent, R^1 includes a first fluoroalkyl-substituted phenyl group, R^2 includes a second fluoroalkyl-substituted phenyl group or a first fluoro/chloro-substituted phenyl group, R^3 includes a third fluoroalkyl-substituted phenyl group or a second fluoro/chloro-substituted phenyl group, and R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains one of the following: water, an alcohol, an alkoxy, a ketone, an ester, an organosiloxane, an amine, a phosphine, an oxime, and substituted analogs thereof, R^1 being different from at least one of R^2 and R^3 ; and

forming a polyether polyol having a number average molecular weight of greater than the number average molecular weight of the low molecular weight initiator in the presence of the Lewis acid catalyst.

4. The method as claimed in claim 3, wherein the Lewis acid catalyst has the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_1$, whereas R^2 is the first fluoro/chloro-substituted phenyl group and R^3 is the second fluoro/chloro-substituted phenyl group that is the same as the first fluoro/chloro-substituted phenyl group.

5. The method as claimed in claim 3, wherein the Lewis acid catalyst has the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas at least one of R^2 and R^3 is a fluoro/chloro-fluoroalkyl-substituted phenyl group, difluoro/chloro-fluoroalkyl-substituted phenyl group, trifluoro/chloro-fluoroalkyl-substituted phenyl group, or tetrafluoro/chloro-fluoroalkyl-substituted phenyl group.

6. The method as claimed in any one of claims 1 to 5, wherein the Lewis acid catalyst has the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas at least one of R^1 , R^2 , and R^3 is a 3,4- or 3,5-bis(fluoroalkyl)-substituted phenyl group.

7. The method as claimed in claim 3, wherein R^4 is a cyclic ether having 3-10 carbon atoms.

8. The method as claimed in claim 3, wherein R^4 is a ketone having 3-10 carbon atoms.

9. The method as claimed in any one of claims 1 to 8, wherein the polyether polyol has an acetal content of less than 0.5 mol% based on a total number of moles of the polyether polyol.

10. The method as claimed in any one of claims 1 to 9, wherein the low molecular weight initiator is a polyether diol or triol derived from at least one selected from propylene oxide, ethylene oxide, and butylene oxide.

11. A method of producing a polyurethane product, the method comprising:
providing a polyether polyol produced according to the method as claimed in any one of claims 1 to 10, and
providing an isocyanate.