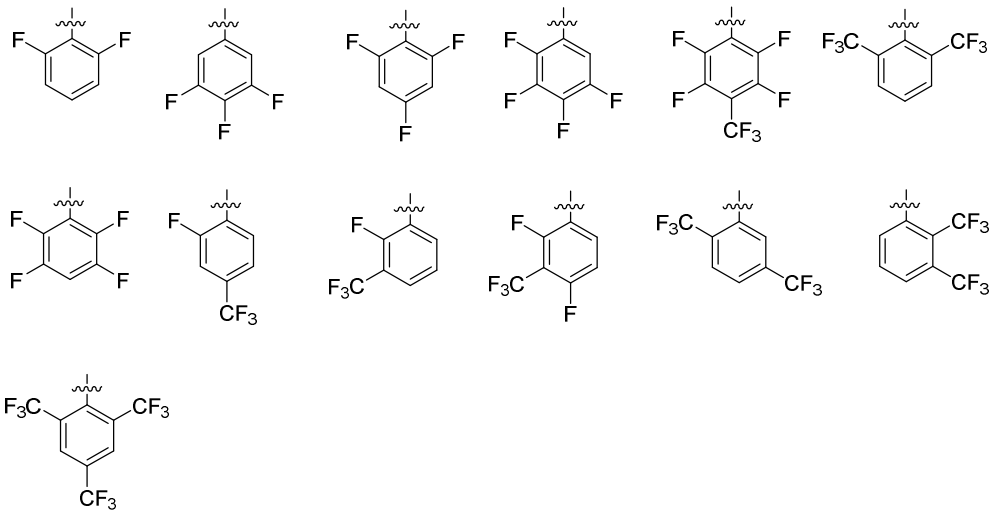
No. 9,388,271. In this process, the tris(pentafluorophenyl)borane catalyst is utilized to polymerize PO in a first step. During the first step, the vapor phase in the autoclave is circulated through a reaction column and distillation column and back to the autoclave reactor in order to minimize side-product formation. In a second step, the KOH catalyst is utilized to polymerize EO onto the PO chain ends. This process is complicated and may require finishing step(s) to remove KOH catalyst residues.

[0009] Therefore, improvements are sought with respect to polymerization catalysts that can be used to prepared polyether polyols, such as polyols derived from at least one selected from propylene oxide, ethylene oxide, and butylene oxide. The improved polymerization catalyst may minimize side-reactions such as those that produce acetals and/or aldehydes, while still allowing for precise control of the polymerization reaction and optionally the production of non-finishing polyols (i.e., polyols that do not require further finishing). The improved polymerization catalyst may be used in such a way so as to not require a catalyst removal step and/or to changing the selectivity of the Lewis acid catalyst itself.

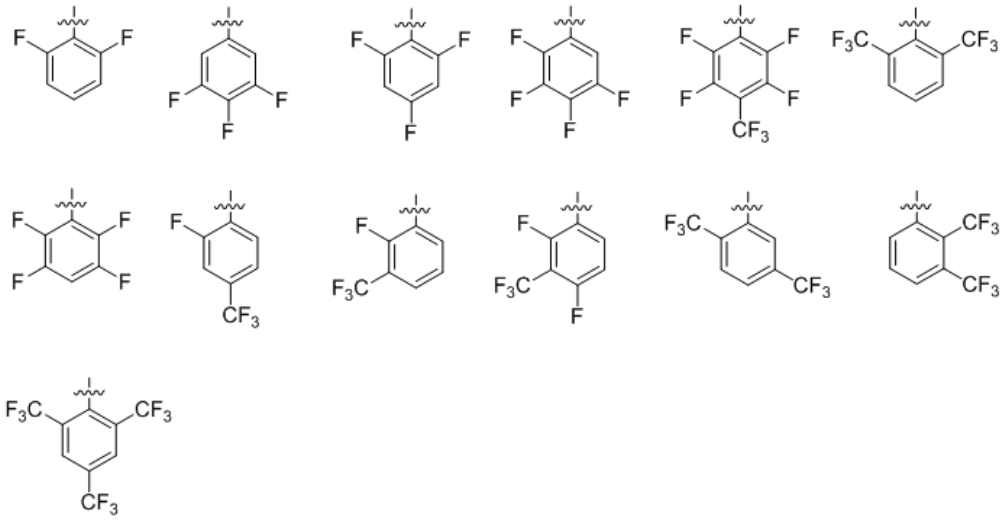
Summary

[0010] Examples may be realized by providing a Lewis acid polymerization catalyst, having a general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, R^1, R^2, R^3, and R^4 are each independent, R^1 is a 3,5-bis(trifluoromethyl)-substituted phenyl group, R^2 is the 3,5-bis(trifluoromethyl)-substituted phenyl group or a first substituted phenyl group selected from Set 1 structures, R^3 is independently a second substituted phenyl group selected from the Set 1 structures, and optional R^4 includes a functional group or functional polymer group. The Set 1 structures are the following:

Ar selected from



[0010a] In one aspect, the present disclosure refers to a Lewis acid polymerization catalyst, comprising: a general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, R^1, R^2, R^3, and R^4 are each independent, R^1 is a 3,5-bis(trifluoromethyl)-substituted phenyl group, R^2 is the 3,5-bis(trifluoromethyl)-substituted phenyl group or a first substituted phenyl group selected from Set 1 structures, R^3 is independently a second substituted phenyl group selected from the Set 1 structures, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains at least one of the following: water, an alcohol, an alkoxyl, a ketone, an ester, an organosilane, an amine, a phosphine, an oxime, and substituted analogs thereof; wherein the Set 1 structures are:



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[0010b] In another aspect, the present disclosure refers to a polyether polyol that is a non-finished polyol that includes the Lewis acid catalyst as disclosed herein.

[0010c] In another aspect, the present disclosure refers to a polyurethane polymer that is the reaction product of the polyether polyol prepared with the Lewis acid catalyst as disclosed herein and an isocyanate.

[0010d] In another aspect, the present disclosure refers to a method of producing a polyether polyol, the method comprising providing the Lewis acid catalyst as disclosed herein.

Detailed Description

[0011] 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.

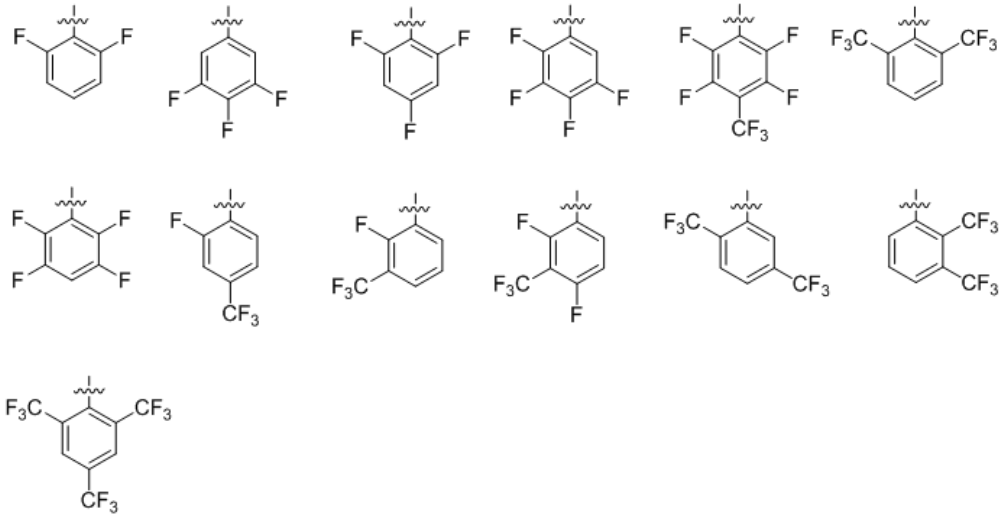
[0012] Further, certain polymerization catalyst may not allow for a desired level of yield for certain products, such as polyols derived from at least ethylene oxide. Ethylene oxide (EO) is an important and widely used monomer in the production of polyether polyols. EO polymerization offers the opportunity to significantly increase the reactivity of polyol with polyisocyanates relative to PO polyols by virtue of the resulting primary hydroxyl end groups. Homopolymers of EO such as certain polyethylene glycols, may find limited use in polyurethanes as they may crystallize readily and/or have a high affinity to water. The high affinity of polyethylene glycols to water may be detrimental to the properties of resultant polyurethanes products, e.g., as the products may be sensitive to the humidity in the environment. The use of block structures formed by the addition of short

Listing of the Claims:

1. A Lewis acid polymerization catalyst, comprising:

a general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_{0 \text{ or } 1}$, whereas M is boron, R^1, R^2, R^3, and R^4 are each independent, R^1 is a 3,5-bis(trifluoromethyl)-substituted phenyl group, R^2 is the 3,5-bis(trifluoromethyl)-substituted phenyl group or a first substituted phenyl group selected from Set 1 structures, R^3 is independently a second substituted phenyl group selected from the Set 1 structures, and optional R^4 includes a functional group or functional polymer group, said functional group or functional polymer group being a molecule that contains at least one of the following: water, an alcohol, an alkoxyl, a ketone, an ester, an organosilane, an amine, a phosphine, an oxime, and substituted analogs thereof;

wherein the Set 1 structures are:



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2. The Lewis acid catalyst as claimed in claim 1, wherein R^2 is the 3,5-bis(trifluoromethyl)-substituted phenyl group.

3. The Lewis acid catalyst as claimed in claim 1, wherein R^2 is the first substituted phenyl group selected from Set 1 structures.

4. The Lewis acid catalyst as claimed in any one of claims 1 to 3, wherein the Lewis acid catalyst has the general formula $M(R^1)_1(R^2)_1(R^3)_1(R^4)_1$.

5. The Lewis acid catalyst as claimed in claim 4, wherein R^4 is a cyclic ether having 3-10 carbon atoms.

6. The Lewis acid catalyst as claimed in claim 4, wherein R^4 is a ketone having 3-10 carbon atoms.

7. The Lewis acid catalyst as claimed in any one of claims 1 to 6, wherein the Lewis acid catalyst is a polymerization catalyst for forming a polyether polyol.

8. A polyether polyol that is a non-finished polyol that includes the Lewis acid catalyst as claimed in any one of claims 1 to 6.

9. A polyurethane polymer that is the reaction product of the polyether polyol prepared with the Lewis acid catalyst as claimed in any one of claims 1 to 6 and an isocyanate.

10. A method of producing a polyether polyol, the method comprising providing the Lewis acid catalyst as claimed in any one of claims 1 to 6.