

PRODUCT AND PROCESS

The present invention concerns viscoelastic polyurethane foams, methods for making them, their uses, and precursor formulations and blends.

Viscoelastic foams are well known in the art, and it is also known to provide viscoelastic
5 flexible polyurethane foams based on polyether carbonate polyols, as disclosed in
US2018044464A1 and US20180237577A1, and from polycarbonate polyols, as disclosed in
US11021564B.

Typically, viscoelastic polyurethane foams are manufactured from precursor materials which
include a blend of polyols. Such blends frequently comprise at least one relatively high (in the
10 region of 3000-5000 Da) molecular weight triol in combination with at least one further lower
(typically <1000 Da) molecular weight polyol, which may also be a triol. The aforesaid
US2018044464A1 discloses the use of a polyether carbonate polyol as (one of) the lower
molecular weight polyol(s). This document discloses the use in this context of a polyether
carbonate polyol with a relatively high OH number (or OHV). The relatively low molecular
15 weight materials disclosed have OHVs of from ≥ 150 mg KOH/g to ≤ 300 mg KOH). An
exemplified higher molecular weight component is a trifunctional polyether polyol.

US20200407485A1 discloses a method for producing polyurethane foams by reaction of the
components: A – a polyol component containing: A1 40 to 100 parts by weight of polyether
carbonate polyol with a hydroxyl number according to DIN 53240-1 of 20 mg KOH/g to 120
20 mg KOH/g, A2 0 to 60 parts by weight of polyether polyol with a hydroxyl number in
accordance with DIN 53240-1 of 20 mg KOH/g to 250 mg KOH/g and an ethylene oxide content
of 0 to 60% by weight, wherein polyether polyol A2 is free from carbonate units; B – B1 a
catalyst, and B2 optionally auxiliary and additional materials; C – water and/or physical
blowing agents; with D – diisocyanates and/or polyisocyanates, wherein the production
25 occurs at a characteristic value of 90 to 120, characterized in that the component A contains
a component: A5 from 0.05 to 10.00 parts by weight of polyester polyol, in relation to the sum
of the parts by weight of the components $A1 + A2 = 100$ parts by weight, said polyester polyol
containing structural units derived from malonic acid.

US20200399466A1 discloses a similar process to that above, with the production of the polyurethane foam occurring in the presence of additional component K which is selected from at least one compound of the following formulas: (1) $(R_1)(R_2)X-C(O)-(Y)_m-Z$; (2) $[(R_1)(R_2)X-C(O)-N(H)-N(H)-C(O)-R_3]_2$; $[(R_1)(R_2)X-R_3-C(O)-N(H)-]_2$, and wherein component K is used in a quantity of 0.05 to 10.00 parts by weight, in relation to the sum of the parts by weight of the components A1+A2 = 100 parts by weight.

US20210070916A1 discloses a process for producing polyurethane foams by reaction of the components: A, B, C and D. Component A comprises a polyol component, comprising A1 which is 40 to 100 parts by weight of polyether carbonate polyol and A2 which is 0 to 60 parts by weight of polyether polyol. Component B can comprise B1 a catalyst, and B2 optionally auxiliary and additive substances. Component C can comprise water and/or physical blowing agents. Component D can comprise di- and/or polyisocyanates. Production is carried out at an index of 90 to 120 and in the presence of a component K, wherein the component K comprises a reaction product of alkoxylated phosphoric acid with 1,3-dicarbonyl compound or carboxylic anhydride.

However, these disclosures fail to appreciate that higher molecular weight CO₂-based polyols (i.e., polyether carbonate, polycarbonate ether or polycarbonate polyols (hereinafter collectively referred to as "CO₂-based polyols") may in fact be used to contribute towards (or in fact completely fulfil) the role of the relatively high Mn polyol in the blend effective as a viscoelastic foam precursor material. Similarly, the inventors disclose in US20180237577A1 viscoelastic foams utilising polyether carbonates with OHV between 150-300.

US11021564B discloses the use of highly alternating linear (2-functional) CO₂-based polycarbonate polyols for the production of high strength soft foams, including viscoelastic foams. The polyols used are highly viscous (330-5000 cP at 80 °C). A maximum of 20% of any single CO₂-based polycarbonate polyol was included in the formulation, with a maximum of 45% of CO₂-based polycarbonate polyols included in the formulation. The CO₂-based polycarbonate polyols disclosed for use in this document exhibit CO₂ contents of at least 33 wt% and sometimes up to nearer 40 wt% and as a consequence are somewhat or even highly viscous, thereby limiting the amount of such material that may be included in a viscoelastic foam precursor polyol blend.

Therefore, this disclosure fails to appreciate that higher molecular weight CO₂-based polyols with moderate viscosities (that is to say without too high a CO₂ content) may be used to contribute towards (or in fact completely fulfil) the role of the relatively high Mn polyol in the blend effective as a viscoelastic foam precursor material and that the provision of lower
5 viscosity CO₂-based polyols may permit their use in a viscoelastic foam precursor polyol blend at significantly higher loadings than would be the case with high viscosity materials, and yet provide viscoelastic properties to the end-product foam and provide foams with excellent properties and a lower carbon footprint than that of conventional foams.

These factors are significant because CO₂-based polyols are established as important materials
10 contributing towards carbon negativity, being end products of carbon dioxide utilisation.

Furthermore, the selection of CO₂-based polyols as the higher molecular weight component in a polyol blend effective as a precursor material for the production of viscoelastic foams allows the selection of other materials for the low molecular weight component that may be equally (or at least also) environmentally sustainable materials. Examples include bio-polyols
15 and recycled polyols as well as further lower molecular weight CO₂-based polyols suggested for use in the prior art as discussed.

Improved properties of viscoelastic foams, with respect to resilience, for example, may also be realised in this context.

According to the present invention there is provided a viscoelastic foam manufactured from
20 starting materials comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂.

The invention also contemplates a blend of polyols suitable as precursor starting materials for viscoelastic foam production, the amount of the at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g being preferably above 20 wt% of the blend,
25 more preferably above 22.5 wt% of the blend, and optionally considerably higher.

Further contemplated is a blend of polyols according to the invention suitable as precursor starting materials for viscoelastic foam production, the amount of all CO₂-based polyols having OHV determined by DIN 53240 of <150 mg KOH/g in the blend being preferably above 40 wt%

of the blend, more preferably at or above 42.5 wt% of the blend, and optionally considerably higher, and wherein the amount of any single CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g is preferably above 15 wt% of the blend, more preferably above 17.5 wt% of the blend, and optionally considerably higher.

- 5 In this specification it is contemplated that a “polyol blend” may mean either a blend in immediate readiness for reaction with isocyanate to produce a foam, or a pre-blend comprising at least one CO₂-based polyol which is subsequently further blended with other materials (optionally including other polyol(s)) to produce the blend in readiness for reaction with isocyanate to produce a foam.
- 10 In some cases it is contemplated to provide a viscoelastic foam manufactured from a polyol blend comprising at least one CO₂-based polyol comprising polyether carbonate polyol having OHV determined by DIN 53240 of <150 mg KOH/g and/or polycarbonate ether polyol having OHV determined by DIN 53240 of <150 mg KOH/g in the absence of alternating polycarbonate polyols and/or of alternating polycarbonate polyols having OHV determined by DIN 53240 of
- 15 <150 mg KOH/g. Avoidance of alternating polycarbonate polyols may provide a formulation with higher stability and lower viscosity.

The invention further provides:

- the use of any of the aforesaid polyol blends or of at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ in the manufacture of viscoelastic foam;
- a formulation for viscoelastic foam production comprising at least one of the aforesaid polyol blends or at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂;
- a polyol blend for viscoelastic foam formulation comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂; and
- a viscoelastic foam derived from a polyol blend comprising at least a relatively high molecular weight component and at least a relatively low molecular weight component, wherein the relatively high molecular weight component is provided at

least in part by a CO₂-based polyol wherein the foam has a resilience <20% (as measured by ball rebound test – ISO8307).

In this specification, by “viscoelastic” we mean in respect of a polyurethane foam or polyurethane soft or flexible foam that such foam has a low ball rebound elasticity according to ISO8307. The ball rebound elasticity (or “resilience”) of viscoelastic foams in accordance with the invention is preferably below 20%, more preferably below 15%, most preferably below 10%.

The CO₂-based polyols having OHV determined by DIN 53240 of <150 mg KOH/g and being useful in the invention typically have Mn of at least about 1,000 Da or at least about 1,500 Da, or at least about 2,000 Da, or at least about 2,500 Da, or at least about 3,000 Da, or at least about 4,000 Da, or at least about 5,000 Da, or at least about 6,000 Da, in some cases up to about 7,500 Da or even about 10,000 Da, for example in the range of from about 1,750 Da to about 5,000 Da or from about 2,000 Da to about 3,000 Da, or from about 3,000 Da to about 10,000 Da, or from about 3,000 Da to about 7,500 Da.

To some extent, Mn (number average molecular weight) is dependent on the type of starting compound used for manufacture of the CO₂-based polyol in question – whether it be a diol or triol, for example. However there may be other factors – for example, such compounds are typically manufactured by means of the catalytic combination of a suitable starting compound with CO₂ and an alkylene oxide – and the choice of alkylene oxide (ethylene oxide or propylene oxide for example) will also have an impact on Mn, as will other conditions of processing and catalytic environment, for example. Such considerations have been discussed in our previous publications, as referenced below.

In one preferred embodiment according to the invention the CO₂-based polyol comprises a triol having Mn in the region of from about 2,000 Da to about 8,000 Da; preferably from about 2,500 Da to about 6,000 Da, or from about 3,000 Da to about 6,000 Da.

In another preferred embodiment according to the invention the CO₂-based polyol comprises a diol having Mn in the region of from about 1,500 Da to about 4,000 Da; preferably from about 1,750 Da to about 2,500 Da.

Another preferred embodiment comprises one or more of the aforesaid triols in combination with one or more of the aforesaid diols.

Regardless of the preferential selection, the requirement that at least one CO₂-based polyol have OHV determined by DIN 53240 of <150 mg KOH/g means that environmentally
5 preferential CO₂-containing polymers contribute at least the relatively high molecular weight component in a polyol blend effective for the manufacture of viscoelastic polyurethane foam.

In some embodiments according to the invention, the starting materials are absent any CO₂-based polyol having OHV determined by DIN 53240 of ≥150 mg KOH/g.

The at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g
10 and comprising from about 5 to about 30 wt% CO₂ may itself be derived from a starting material comprising a diol and/or a triol. Typically, such a starting material is reactively combined with CO₂ and one or more alkylene oxides in the manner taught in, for example in our WO2017037441A1 and WO2019081931A1, or in US2018044464A1, the contents of each of which are hereby incorporated by reference.

15 Certain embodiments may comprise more than one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g.

In that case, it is contemplated that a first CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g may be a diol, or be derived from a diol starting material, and a
20 second CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g may be a triol, or be derived from a triol starting material.

The starting materials for viscoelastic foam manufacture may further comprise at least one additional polyol, which may for example be selected from other CO₂-containing polyol, polyether polyol, polyester polyol, bio polyol (e.g. natural oil polyol), including recyclates of any thereof.

25 Bio polyol(s) or recycled polyols are preferred for the at least one additional polyol.

Diol or diol-derived and triol or triol-derived CO₂-based polyol may be present each in that case independently be present in an amount of from ≥ 0 to ≤ 75 parts per hundred by weight, with any balance to 100 contributed by the at least one additional polyol.

Preferably the balance provided by the at least one additional polyol is in the range of from
5 >0 to ≤ 75 parts per hundred.

The at least one additional polyol may have an OHV determined by DIN 53240 of ≥ 100 mg KOH/g, for example ≥ 125 mg KOH/g, perhaps ≥ 150 mg KOH/g, or even ≥ 200 , 250 or 300 mg KOH/g.

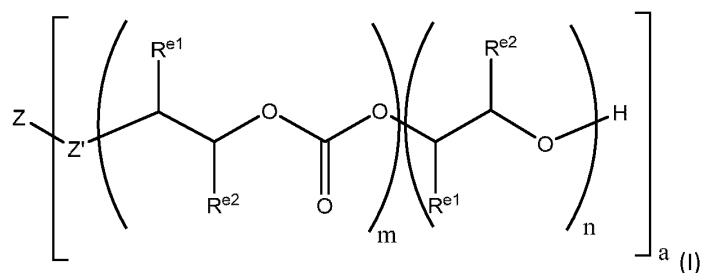
The OHV of the at least one CO₂-based polyol having OHV determined by DIN 53240 of <150
10 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ may for example be in the range of from about 25 to <150 mg KOH/g or from about 25 to <115 mg KOH/g.

The CO₂ content of the at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ is preferably below 27.5wt% CO₂, more preferably below 25wt% CO₂, most preferably below 20wt% CO₂.

15 In a blend of polyols according to the invention suitable as precursor starting materials for viscoelastic foam production, the amount of the at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ in the blend is preferably above 20 wt%, more preferably above 22.5 wt%, and may be considerably higher.

20 In a blend of polyols according to the invention suitable as precursor starting materials for viscoelastic foam production, the amount of all CO₂-based polyols having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ in the blend is preferably above 40 wt%, more preferably at or above 42.5 wt%, and may be considerably higher.

25 Polycarbonate polyols, and polycarbonate ether polyols useful in the invention may have the formula (I):



Wherein:

Z is selected from optionally substituted alkylene, alkenylene, alkynylene, heteroalkylene, heteroalkenylene, heteroalkynylene, cycloalkylene, cycloalkenylene, heterocycloalkylene, heterocycloalkenylene, arylene, heteroarylene, or Z may be a combination of any of these groups, for example Z may be an alkylarylene, heteroalkylarylene, heteroalkylheteroarylene or alkylheteroarylene group. Preferably Z is alkylene, heteroalkylene, arylene, or heteroarylene;

Z' is selected from -O-, -NR'-, -S-, -OC(O)O-, -C(O)O-, -P(O)(OR')O-, -PR'(O)(O-)2 or -PR'(O)O- (wherein R' may be H, or optionally substituted alkyl, heteroalkyl, aryl, heteroaryl, cycloalkyl or heterocycloalkyl. Preferably R' is H or optionally substituted alkyl). Preferably Z' may be -C(O)O-, -NR'- or -O-, and more preferably each Z' may be -O-, -C(O)O- or a combination thereof. Even more preferably each Z' may be -O-;

a is an integer which is at least 2, preferably a is in the range of between 2 and 8, preferably a is in the range of from 2 to 6, more preferably 2 or 3;

m is at least 1 and n may be zero or higher;

each R^{e1} is independently selected from H, halogen, hydroxyl, or optionally substituted alkyl, alkenyl, alkynyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, heteroalkyl or heteroalkenyl. Preferably R^{e1} may be selected from H or optionally substituted alkyl; and

each R^{e2} is independently selected from H, halogen, hydroxyl, or optionally substituted alkyl, alkenyl, alkynyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, heteroalkyl or heteroalkenyl. Preferably R^{e2} may be selected from H or optionally substituted alkyl.

R^{e1} and R^{e2} may together form a saturated, partially unsaturated or unsaturated ring containing carbon and hydrogen atoms, and optionally one or more heteroatoms (e.g., O, N or S). For example, R^{e1} and R^{e2} may together form a 5 or six membered ring.

In the polymers of formula (I), the adjacent monomer units in the backbone may be head-to-tail linkages, head-to-head linkages or tail-to-tail linkages.

It will also be appreciated that formula (I) does not require the carbonate links and the ether links (when present) to be present in two distinct "blocks" in each of the sections defined by "a", but instead the carbonate and ether (when present) repeating units may be statistically distributed along the polymer backbone, or may be arranged so that the carbonate and ether linkages (when present) are not in two distinct blocks.

Thus, the polycarbonate ether polyol prepared by the method of the invention (e.g., a polymer of formula (I)) may be referred to as a random copolymer, a statistical copolymer, an alternating copolymer, or a periodic copolymer.

Further detail concerning these polymers and their methods of manufacture is taught in our WO2017037441A1, as aforesaid, and also the methods described in WO2019081931A1, or in US2018044464A1, for example. Other methods will be apparent to the skilled addressee, based on the reaction of an alkylene oxide with CO_2 in the presence of suitable starter(s) and catalyst(s).

Viscoelastic foams in accordance with the invention may be prepared by reacting the polyol or polyol blend suitable for use in the invention with an isocyanate compound, such as, 2,4- and/or 2,6-toluylenediisocyanate and/or modified polyisocyanates which are derived from 2,4- and/or 2,6-TDI, 2,4- and/or 2,6-toluylenediisocyanate, as described in US2018044464A1, for example. The isocyanate compound may comprise toluylene diisocyanate (TDI) comprising a mixture of 2,4- and 2,6- TDI isomers. The ratio of 2,4- to 2,6- TDI isomers in the TDI mixture may be, for example, 65:35 or preferably 80:20.

Typical viscoelastic foams use the more expensive TDI 65:35 grade. However, the inventors of the present invention have surprisingly and beneficially found that viscoelastic foams can be produced using the TDI 80:20 grade when the polyol blend of the present invention is used in

the foam formulation. Without wishing to be bound by any such theory, it is believed that the polyol blend of the present invention imparts additional viscoelastic properties to the foam which consequently allows TDI 80:20 to be successfully used.

5 In this specification, by “viscoelastic” we mean in respect of a polyurethane foam or polyurethane soft or flexible foam that such foam has a low ball rebound elasticity according to ISO8307. The ball rebound elasticity (or “resilience”) of viscoelastic foams in accordance with the invention is preferably below 20%, more preferably below 15%, most preferably below 10%.

10 The foam in accordance with the invention may comprise one or more additives as described in US4248930A, for example. These additives may include blowing agents, surfactants (surface active additives) and/or catalysts.

The surfactant may be any known surfactant for use in polyurethane foam manufacture, for example organosiloxane compounds or silicone-based compounds e.g., those sold under the tradename TEGOSTAB™ (produced by EVONIK™).

15 The catalyst may be any known catalyst for use in polyurethane foam manufacture, for example amine-based compounds e.g., those sold under the tradename DABCO™ or POLYCAT™ (produced by EVONIK™), and metal catalysts e.g., those sold under the tradename POLYCAT™ and KOSMOS™ (produced by EVONIK™).

20 The at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ preferably exhibits a viscosity (at 25°C) of less than about 100,000 cP, preferably less than about 50,000 cP, most preferably less than about 15,000 cP.

25 The invention finds application in for example polyurethane soft foams which are used extensively in the automotive and construction industries as well as in textiles, furniture, bedding and sound-proofing materials.

Examples

A number of polycarbonate ether polyols are prepared by the methods described in WO2017037441A1 and WO2019081931A1 having a range of molecular weights.

A blend of high and low molecular weight materials is prepared and reactively combined with 2,4- and/or 2,6-toluylene diisocyanate under the conditions effective create a viscoelastic foam.

Polyols: Polyol A1 is a 100% propylene oxide polyether polyol with OHV = 250 mg KOH/g, functionality = 3, Mn = 675 Da, and viscosity = 260 cP (at 25°C). Polyol A2, a polycarbonate ether polyol with OHV = 56 mg KOH/g, functionality ≈ 3, Mn = 3000 Da, a CO₂ content of ~10 wt% and a viscosity of 2500 cP (at 25°C). Polyol A3, a high ethylene oxide content polyether triol of 5000 Da, used as a cell opener and OHV = 32, viscosity = 1350 cP (at 25°C). Polyol A4, a polycarbonate ether polyol with OHV = 56 mg KOH/g, functionality ≈ 2, Mn = 2000 Da, a CO₂ content of ~18wt% and a viscosity of 4700 cP (at 25°C).

General method: Polyols, water, surfactant, and amine catalysts are accurately weighed into a plastic beaker. The formulation is blended at room temperature at 2000 RPM for 50 s. Stannous octoate is added and the formulation blended at 2000 RPM for 10 s, before toluylene diisocyanate (TDI) 80:20 is added and the formulation blended at 2000 RPM for a further 10 s. The formulation is quickly transferred into a foaming box lined with parchment paper and allowed to rise. Upon completion of rise, the foam is allowed to cure at room temperature for 5 min before completing the cure in an oven at 140°C. After 5 min the foam is taken from the oven and removed from the parchment paper. The foam bun was allowed to stand at room temperature for 24 h before being processed for testing.

The following standard test methods were used to determine various properties of the foam:

Property	Standard Test Method
Density	ASTM D3574-A (Core Density)
Resilience	ASTM D3574-H (Equivalent to ISO-8307)
Tensile Strength	ASTM D3574-E
Elongation	ASTM D3574-E

Compression (CLD)	ISO 3386
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(In the following tables, component quantities are stated as pphp (parts per hundred polyol).

Example 1:

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Component	Formulation 1
Polyol A1	45.0
Polyol A2	45.0
Polyol A3	10.0
Water	1.70
Tegostab™ B8160	1.50
DABCO BL11	0.15
DABCO 33LV	0.15
Stannous Octoate	0.03
TDI 80:20	34.1
Rise Time (s)	235
Tack Free Time (min)	3.5
Density (kg/m³)	56.3
Resilience(%)	<3
Tensile Strength (kPa)	58.0
Ultimate Elongation (%)	342
CLD, 40% (kPa)	1.1

Example 2:

Component	Formulation 2
Polyol A1	42.5
Polyol A2	25.5
Polyol A3	15.0
Polyol A4	17.0
Water	1.70
Tegostab™ B8160	1.50
DABCO BL11	0.25
DABCO 33LV	0.25
TDI 80:20	32.6

Rise Time (s)	175
Tack Free Time (min)	3.0
Density (kg/m ³)	61.0
Resilience(%)	6.8
Tensile Strength (kPa)	44.3
Ultimate Elongation (%)	398
CLD, 40% (kPa)	0.6

Example 3:

Component	Formulation 3
Polyol A1	42.5
Polyol A3	15.0
Polyol A5	42.5
Water	1.70
Tegostab™ B8160	1.50
DABCO BL11	0.25
DABCO 33LV	0.25
TDI 80:20	34.0
Rise Time (s)	146
Tack Free Time (min)	3.0
Density (kg/m ³)	51.0
Resilience(%)	4.6
Tensile Strength (kPa)	62.7
Ultimate Elongation (%)	370
CLD, 40% (kPa)	1.0

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Example 4:

Component	Formulation 4
Polyol A1	35.0
Polyol A3	10.0
Polyol A6	45.0
Water	1.33
Tegostab™ B8160	1.50
Ortegol 204	1.50
DABCO BL11	0.25
DABCO 33LV	0.25

TDI 80:20	33.5
Rise Time (s)	160
Tack Free Time (min)	5.0
Density (kg/m ³)	54.8
Resilience(%)	9.4
Tensile Strength (kPa)	67.0
Ultimate Elongation (%)	271
CLD, 40% (kPa)	0.9

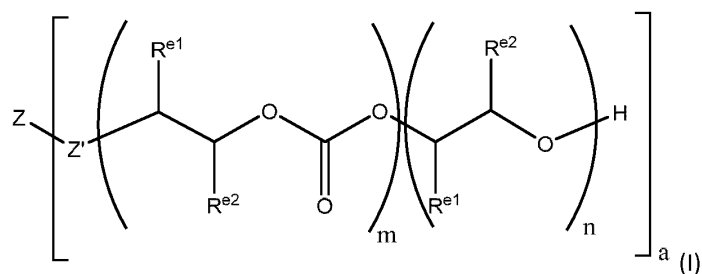
The results demonstrate that satisfactory viscoelastic foams with excellent resilience properties can be manufactured using the methods and materials described herein.

CLAIMS

1. A polyol blend for viscoelastic foam formulation comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂.
2. A polyol blend for viscoelastic foam formulation comprising at least one comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g in an amount above 20 wt% of the blend, optionally above 22.5 wt% of the blend.
3. A polyol blend for viscoelastic foam formulation comprising at least one comprising a plurality of CO₂-based polyols having OHV determined by DIN 53240 of <150 mg KOH/g in an amount above 40 wt% of the blend, optionally at or above 42.5 wt% of the blend.
4. The blend of claim 3 wherein the amount of any single CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g is above 15 wt% of the blend, optionally above 17.5 wt% of the blend.
5. A polyol blend for viscoelastic foam formulation comprising at least one CO₂-based polyol comprising a polyether carbonate polyol having OHV determined by DIN 53240 of <150 mg KOH/g and/or polycarbonate ether polyol having OHV determined by DIN 53240 of <150 mg KOH/g in the absence of alternating polycarbonate polyols and/or of alternating polycarbonate polyols having OHV determined by DIN 53240 of <150 mg KOH/g.
6. The blend of any one of claims 1 to 5 wherein the CO₂-based polyol has Mn of at least about 1,000 Da or at least about 1,500 Da, or at least about 2,000 Da, or at least about 2,500 Da, or at least about 3,000 Da, or at least about 4,000 Da, or at least about 5,000 Da, or at least about 6,000 Da, optionally up to about 7,500Da or about 10,000 Da, optionally in the range of from about 1,750 Da to about 5,000 Da or from about 2,000 Da to about 3,000 Da, or from about 3,000 Da to about 10,000 Da, or from about 3,000 Da to about 7,500 Da.

7. The blend of any one of claims 1 to 6 wherein the CO₂-based polyol comprises a triol having Mn in the region of from about 2,000 Da to about 8,000 Da; optionally from about 2,500 Da to about 6,000 Da, or from about 3,000 Da to about 6,000 Da.
8. The blend of any one of claims 1 to 7 wherein the CO₂-based polyol comprises a diol having Mn in the region of from about 1,500 Da to about 4,000 Da; preferably from about 1,750 Da to about 2,500 Da.
9. The blend of any one of claims 1 to 8 being absent any CO₂-based polyol having OHV determined by DIN 53240 of ≥ 150 mg KOH/g.
10. The blend of any one of claims 1 to 9 comprising more than one CO₂-based polyol having OHV determined by DIN 53240 of < 150 mg KOH/g.
11. The blend of claim 10 wherein a first CO₂-based polyol is a diol, or is derived from a diol starting material, and a second CO₂-based polyol is a triol, or is derived from a triol starting material.
12. The blend of claim 11 wherein diol or diol-derived and triol or triol-derived CO₂-based polyol are independently present in an amount of from ≥ 0 to ≤ 75 parts per hundred by weight.
13. The blend of any one of claims 1 to 12 further comprising at least one additional polyol, optionally selected from other CO₂-containing polyol, polyether polyol, polyester polyol, bio polyol (e.g. natural oil polyol), including recyclates of any thereof.
14. The blend of claim 13 wherein the at least one additional polyol comprises a bio polyol.
15. The blend of claim 13 or claim 14 wherein at least one additional polyol is present in an amount from ≥ 0 to ≤ 75 parts per hundred by weight.

16. The blend of any one of claims 13 to 15 wherein the at least one additional polyol has an OHV determined by DIN 53240 of ≥ 100 mg KOH/g, for example ≥ 125 mg KOH/g, perhaps ≥ 150 mg KOH/g, or even ≥ 200 , 250 or 300 mg KOH/g.
17. The blend of any one of claims 1 to 16 wherein the OHV of the at least one CO₂-based polyol having OHV determined by DIN 53240 of < 150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂ is in the range of from about 25 to < 150 mg KOH/g.
18. The blend of any one of claims 1 to 17 wherein the CO₂-based polyol has the formula (I):



wherein:

Z is selected from optionally substituted alkylene, alkenylene, alkynylene, heteroalkylene, heteroalkenylene, heteroalkynylene, cycloalkylene, cycloalkenylene, heterocycloalkylene, heterocycloalkenylene, arylene, heteroarylene, or Z may be a combination of any of these groups, for example Z may be an alkylarylene, heteroalkylarylene, heteroalkylheteroarylene or alkylheteroarylene group, preferably Z is alkylene, heteroalkylene, arylene, or heteroarylene;

Z' is selected from $-\text{O}-$, $-\text{NR}'-$, $-\text{S}-$, $-\text{OC}(\text{O})\text{O}-$, $-\text{C}(\text{O})\text{O}-$, $-\text{P}(\text{O})(\text{OR}')\text{O}-$, $-\text{PR}'(\text{O})(\text{O})_2$ or $-\text{PR}'(\text{O})\text{O}-$ (wherein R' may be H, or optionally substituted alkyl, heteroalkyl, aryl, heteroaryl, cycloalkyl or heterocycloalkyl. Preferably R' is H or optionally substituted alkyl). Preferably Z' may be $-\text{C}(\text{O})\text{O}-$, $-\text{NR}'-$ or $-\text{O}-$, and more preferably each Z' may be $-\text{O}-$, $-\text{C}(\text{O})\text{O}-$ or a combination thereof, optionally wherein each Z' is $-\text{O}-$;

a is an integer which is at least 2, optionally in the range of between 2 and 8, optionally a is in the range of from 2 to 6, optionally 2 or 3;

m is at least 1 and n may be zero or higher;

each R^{e1} is independently selected from H, halogen, hydroxyl, or optionally substituted alkyl, alkenyl, alkynyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, heteroalkyl or heteroalkenyl. Preferably R^{e1} may be selected from H or optionally substituted alkyl; and

each R^{e2} is independently selected from H, halogen, hydroxyl, or optionally substituted alkyl, alkenyl, alkynyl, cycloalkyl, heterocycloalkyl, aryl, heteroaryl, heteroalkyl or heteroalkenyl. Preferably R^{e2} may be selected from H or optionally substituted alkyl.

19. The blend of claim 18 wherein R^{e1} and R^{e2} together form a saturated, partially unsaturated or unsaturated ring containing carbon and hydrogen atoms, and optionally one or more heteroatoms (e.g., O, N or S), optionally wherein R^{e1} and R^{e2} together form a five or six membered ring.
20. The use of at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂, and/or of blend according to any one of claims 1 to 19 in the manufacture of viscoelastic foam.
21. A formulation for viscoelastic foam production comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂, and/or comprising blend according to any one of claims 1 to 19.
22. A viscoelastic foam manufactured from starting materials comprising at least one CO₂-based polyol having OHV determined by DIN 53240 of <150 mg KOH/g and comprising from about 5 to about 30 wt% CO₂, and/or comprising a blend according to any one of claims 1 to 19.

23. A viscoelastic foam derived from a polyol blend comprising at least a relatively high molecular weight component and at least a relatively low molecular weight component, wherein the relatively high molecular weight component is provided at least in part by a CO₂-based polyol wherein the foam has a resilience <20% (as measured by ball rebound test – ISO8307).
24. A viscoelastic foam according to claim 23 wherein the blend is a blend according to any one of claims 1 to 19.
25. Use of a viscoelastic foam according to any one of claims 22 to 24 in the manufacture of a useful article.
26. A useful article manufactured from the viscoelastic foam of any one of claims 21 to 25.
27. A process for preparing a viscoelastic foam comprising reacting the polyol blend according to any one of claims 1 to 19 with an isocyanate compound.
28. The process according to claim 27, wherein the isocyanate compound comprises 2,4-toluylene diisocyanate and/or 2,6-toluylene diisocyanate.
29. The process according to claim 27 or claim 28, wherein the isocyanate compound comprises a mixture of 2,4-toluylene diisocyanate and 2,6-toluylene diisocyanate, optionally wherein the ratio of 2,4-toluylene diisocyanate to 2,6-toluylene diisocyanate in the mixture is 80:20.