up, and needs to be cooled down, before the next and /or final compression stage. This thermal effect could lead to premature formation of radicals, and consequently, polymer in the cylinder packing and/or valves, leading potentially to disturbed lubrication in the cylinder packing and/or higher cylinder discharge temperatures, by recompression of the ethylene due to leaking cylinder valves.

As discussed above, there remains a need for new ethylene-based polymers that have higher melt strengths and higher densities, and which can be polymerized with minimal reactor fouling and good process and reactor stability. These needs have been met by the following invention.

SUMMARY

The disclosure provides a process to form an ethylene-based polymer, said process comprising polymerizing ethylene and at least one asymmetrical polyene, comprising an "alpha, beta unsaturated – carbonyl end" and a "C-C double bond end," and

wherein the polymerization takes place in the presence of at least one free-radical initiator; and wherein the polymerization takes place in a reactor configuration comprising at least two reaction zones, reaction zone 1 and reaction zone i ($i \geq 2$), wherein reaction zone i is downstream from reaction zone 1; and

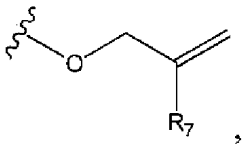
wherein at least one chain transfer agent (CTA) is added to the polymerization, and wherein the CTA is a saturated hydrocarbon or an unsaturated hydrocarbon.

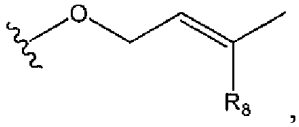
In one aspect, there is provided a process to form an ethylene-based polymer, said process comprising polymerizing ethylene and at least one asymmetrical polyene, comprising an "alpha, beta unsaturated – carbonyl end" and a "C-C double bond end," and

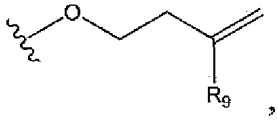
wherein the polymerization takes place in the presence of at least one free-radical initiator, and wherein the polymerization takes place in a reactor configuration comprising at least two reaction zones, reaction zone 1 and reaction zone i ($i \geq 2$), wherein reaction zone i is downstream from reaction zone 1; and

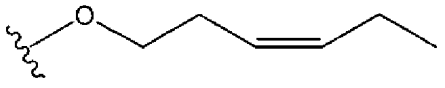
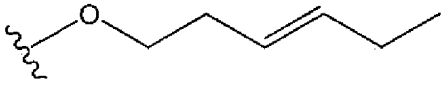
wherein at least one chain transfer agent (CTA) is added to the polymerization, and wherein the CTA is a saturated hydrocarbon or an unsaturated hydrocarbon and

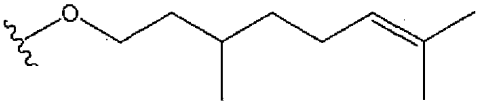
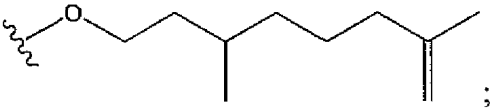
wherein the "C-C double bond end" of the asymmetrical polyene is selected from the group consisting of the following:

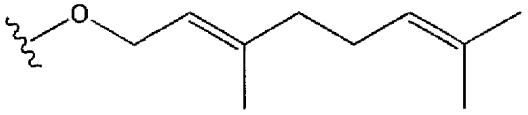
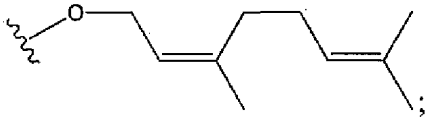
1)  , wherein R7 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

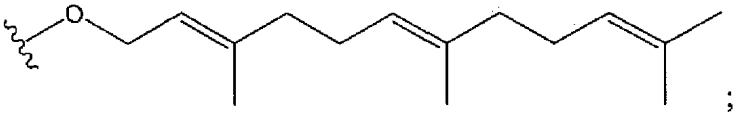
2)  , wherein R8 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

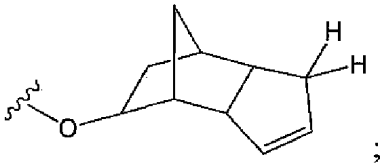
3)  , wherein R9 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

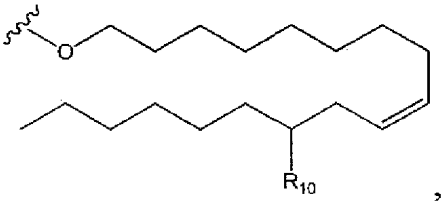
4)  ; 5)  ;

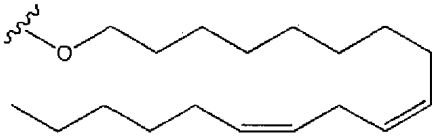
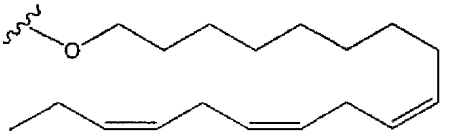
6)  ; 7)  ;

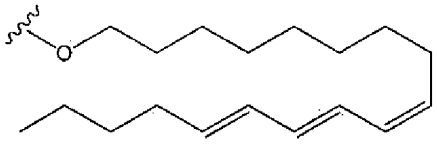
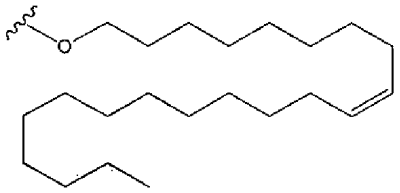
8)  ; 9)  ;

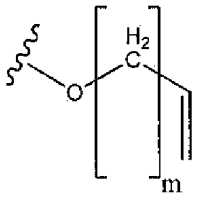
10)  ;

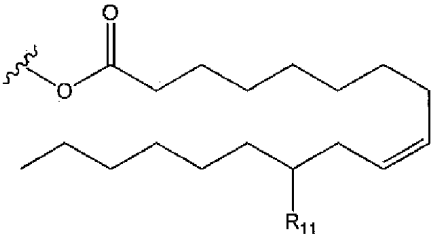
11)  ;

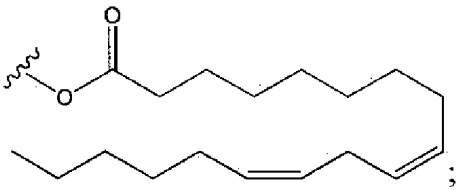
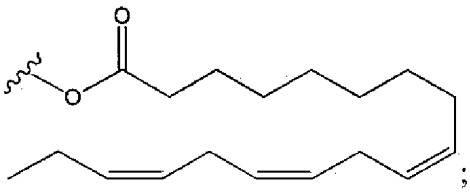
12)  , wherein R10 is selected from H, or OH;

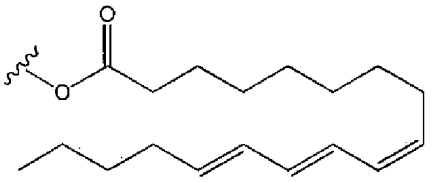
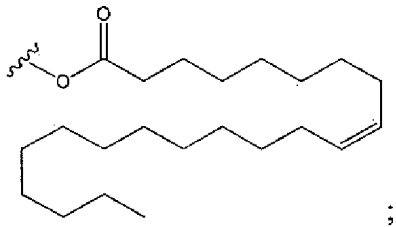
13)  14)  ;

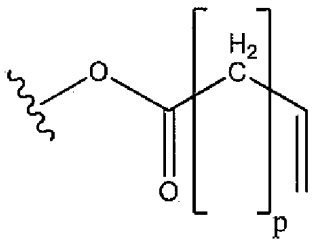
15)  ; 16)  ;

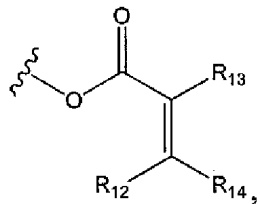
17)  , wherein m = 1 to 20

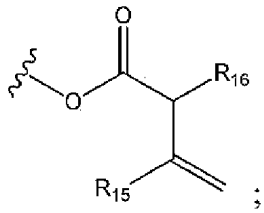
18)  , wherein R11 is selected from H, or OH;

19)  ; 20)  ;

21)  ; 22)  ;

23)  , wherein p = 1 to 20

24)  , wherein R12 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; R13 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; and R14 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3, or Ph; and

25)  ; wherein R15 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; R16 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3.

In another aspect, there is provided an ethylene-based polymer formed from the process as defined herein.

In another aspect, there is provided a composition comprising the ethylene-based polymer as defined herein.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 depicts a flow scheme of a high pressure polymerization configuration.

Figure2 shows a flow diagram used for Comparative Example A', Inventive Examples 1' and 2'.

DETAILED DESCRIPTION

As discussed above, the invention provides a process to form an ethylene-based polymer, said process comprising polymerizing ethylene and at least one asymmetrical polyene, comprising an "alpha, beta unsaturated – carbonyl end" and a "C-C double bond end," and wherein the polymerization takes place in the presence of at least one free-radical initiator; and

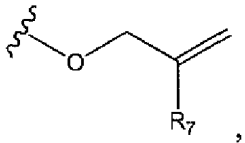
CLAIMS

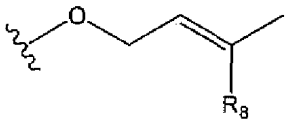
1. A process to form an ethylene-based polymer, said process comprising polymerizing ethylene and at least one asymmetrical polyene, comprising an "alpha, beta unsaturated – carbonyl end" and a "C-C double bond end," and

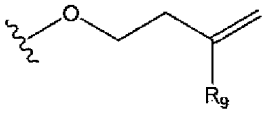
wherein the polymerization takes place in the presence of at least one free-radical initiator, and wherein the polymerization takes place in a reactor configuration comprising at least two reaction zones, reaction zone 1 and reaction zone i ($i \geq 2$), wherein reaction zone i is downstream from reaction zone 1; and

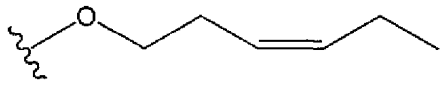
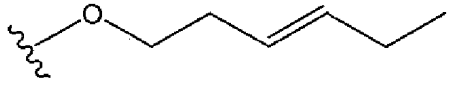
wherein at least one chain transfer agent (CTA) is added to the polymerization, and wherein the CTA is a saturated hydrocarbon or an unsaturated hydrocarbon; and

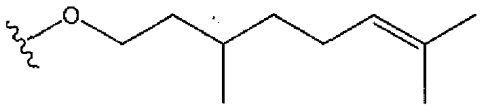
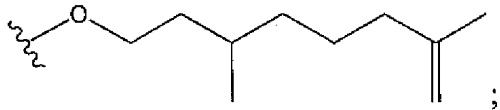
wherein the "C-C double bond end" of the asymmetrical polyene is selected from the group consisting of the following:

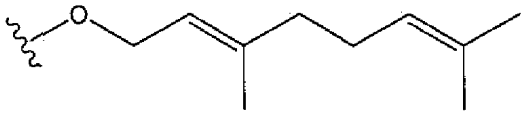
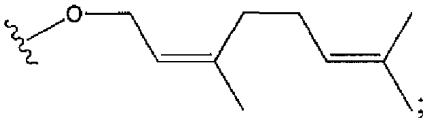
1) , wherein R7 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

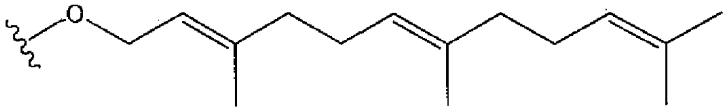
2) , wherein R8 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

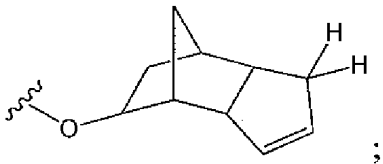
3) , wherein R9 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3;

4) ; 5) ;

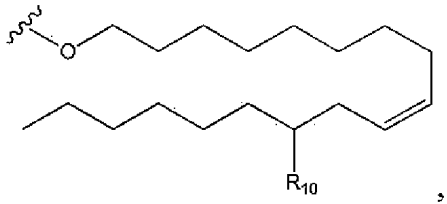
6) ; 7) ;

8) ; 9) ;

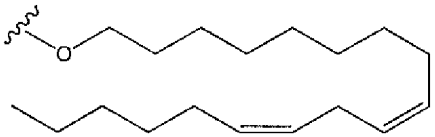
10) ;

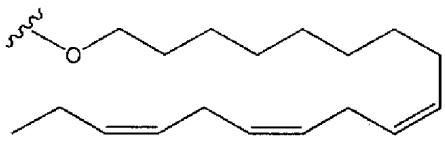
11) 

;

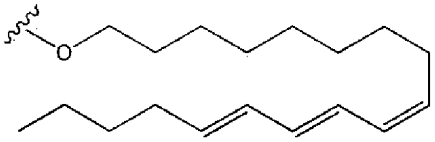
12) 

, wherein R10 is selected from H, or OH;

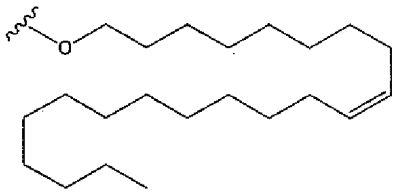
13) 

14) 

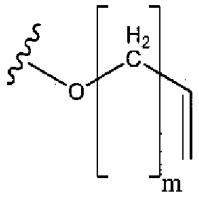
;

15) 

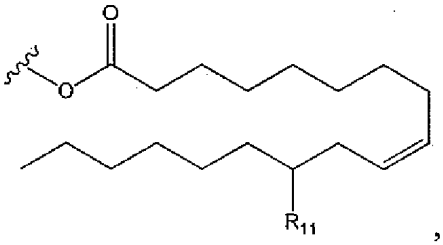
;

16) 

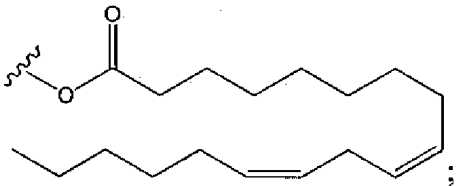
;

17) 

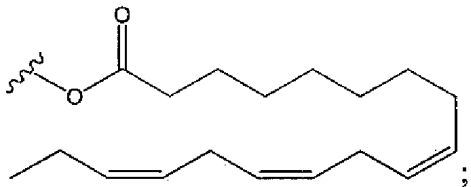
, wherein m = 1 to 20

18) 

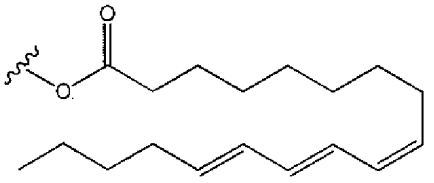
, wherein R11 is selected from H, or OH;

19) 

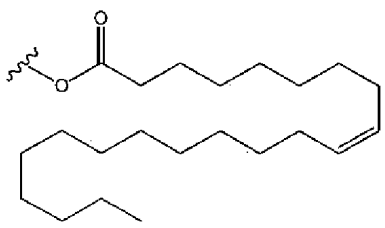
;

20) 

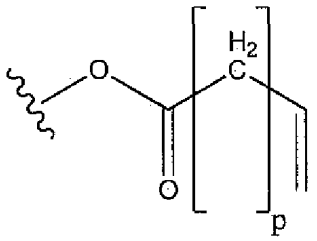
;

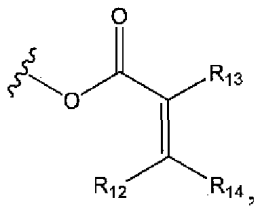
21) 

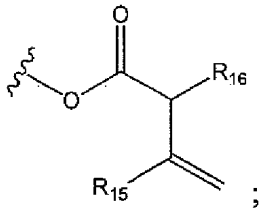
;

22) 

;

23)  , wherein p = 1 to 20

24)  , wherein R12 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; R13 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; and R14 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3, or Ph; and

25)  ; wherein R15 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3; R16 is selected from H, or C1-C6 alkyl, further a C1-C3 alkyl and further CH_3.

2. The process of claim 1, wherein the CTA is selected from an alkane, an alkene, or a combination thereof.

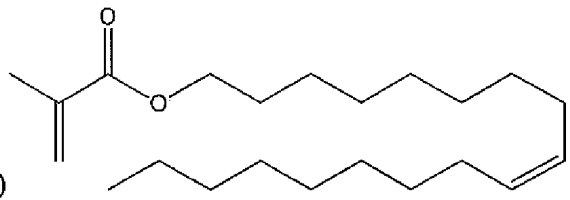
3. The process of claim 1 or claim 2, wherein the polyene is subject to an "oxygen removal step" prior to being fed to a reaction zone.

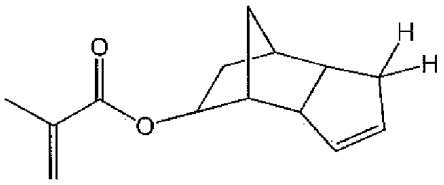
4. The process of any one of the previous claims, wherein the polyene is stored in a feed vessel, and wherein the feed vessel has a "head-space gas" comprising less than 5.0 volume percent oxygen.

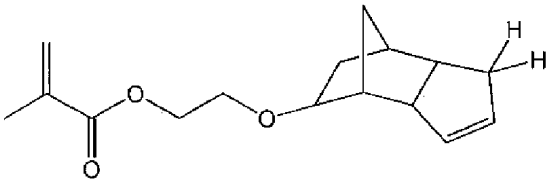
5. The process of any one of the previous claims, wherein the polyene is fed through a compression stage directly into the reaction zone or directly into the feed to the reaction zone.

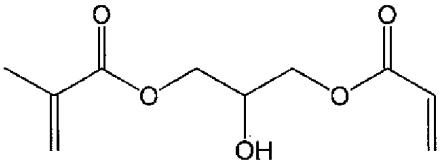
6. The process of any one of previous claims, wherein the polyene is fed directly into the reaction zone or directly into the feed to the reaction zone.

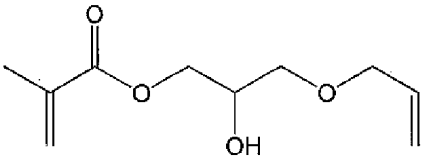
7. The process of any one of the previous claims, wherein the maximum temperature of the first reaction zone is greater than the maximum temperature of each consecutive reaction zone, downstream from the first reaction zone.

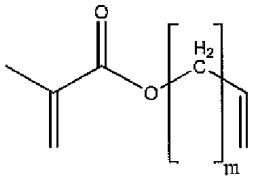
v)  ;

vi)  ;

vii)  ;

viii)  ;

ix)  ; and

x)  , where m = 1 to 20.

14. An ethylene-based polymer formed from the process of any one of the previous claims.

15. A composition comprising the ethylene-based polymer of claim 14.