level in the atmosphere is necessary to avoid growth of certain pathogen anaerobic bacteria, like Clostridium botulinum.

To keep a certain low oxygen level in the package, it is necessary to match the ingress of oxygen into the package with the rate of oxygen consumption by the oxygen scavenging composition. This could potentially be achieved by lowering the content of oxygen scavenging composition in the package. However, this would come at the expense of the overall oxygen scavenging capacity of the package, thereby reducing the shelf life of the contained product article.

It is therefore desirable to provide an oxygen scavenging system, which is able to finely tune the rate of oxygen scavenging reaction to a desired reduced level and to maintain this level over the intended shelf-life of the product, thus providing high scavenging capacity.

It was found surprisingly that certain polyether-polyester copolymers as hereinafter described can effectively be used to effect and control oxygen scavenging in a thermoplastic material.

SUMMARY OF THE INVENTION

In one aspect, there is provided a polyether-polyester copolymer comprising
(i) polyether segments wherein at least one polyether segment contains at least one polytetramethylene oxide segment,
(ii) polyester segments,
(iii) bridging elements of the structure –CO-R2-CO-, wherein R2 represents an optionally substituted bivalent hydrocarbon residue consisting of 1 to 100 carbon atoms;
(iv) one or two end-caps R1-O-(C_2-C_4-O-)$_e$-*, wherein R1 is an optionally substituted hydrocarbon residue and e is an integer of from 0 to 1000, wherein * represents a bond to a bridging element (iii).

In another aspect, there is provided a method of preparing a polyether-polyester copolymer as described herein comprising a polycondensation of the polyether segments containing at least one polytetramethylenoxide segment, the polyester segments, the bridging elements and the end-caps.

In another aspect, there is provided an active oxygen barrier composition comprising a polyether-polyester copolymer as described herein and a transition metal catalyst.

In another aspect, there is provided a plastic material comprising:
a component a) which is a thermoplastic polymer;
a component b) which is a polyether-polyester copolymer as described herein; and
a component c) which is a transition metal catalyst.

A subject of the present invention is a polyether-polyester copolymer comprising

(i) polyether segments wherein at least one polyether segment contains at least one polytetramethylene oxide segment,

(ii) polyester segments,

(iii) bridging elements of the structure –CO-R^2-CO-, wherein R^2 represents an optionally substituted bivalent hydrocarbon residue consisting of 1 to 100 carbon atoms wherein the substituents are preferably C_1-C_5-alkoxy, nitro, cyano or sulfo or a combination thereof;

(iv) one or two end-caps R^1-O-(C_2-C_4-O-)$_e$-*, wherein R^1 is an optionally substituted hydrocarbon residue and e is an integer of from 0 to 1000.

Patent Claims

1. A polyether-polyester copolymer comprising

(i) polyether segments wherein at least one polyether segment contains at least one polytetramethylene oxide segment,

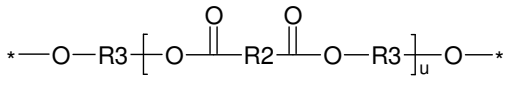
(ii) polyester segments,

(iii) bridging elements of the structure –CO-R2-CO-, wherein R2 represents an optionally substituted bivalent hydrocarbon residue consisting of 1 to 100 carbon atoms;

(iv) one or two end-caps R1-O-(C_2-C_4-O-)$_e$-*, wherein R1 is an optionally substituted hydrocarbon residue and e is an integer of from 0 to 1000, wherein * represents a bond to a bridging element (iii).

2. The polyether-polyester copolymer as claimed in claim 1, wherein the polyether segments (i) contain ethylene oxide segments, propylene oxide segments or a combination thereof.

3. The polyether-polyester copolymer as claimed in claim 1 or 2, wherein the polyester segments (ii) are represented by formula (II):



(II)

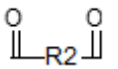
wherein

* represents a bond to a bridging element (iii),

R2 and R3 independently of each other represent an optionally substituted hydrocarbon residue consisting of 1 to 100 carbon atoms, and

u is an integer between 1 and 50.

4. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein bridging elements are described by formula (III)



(III)

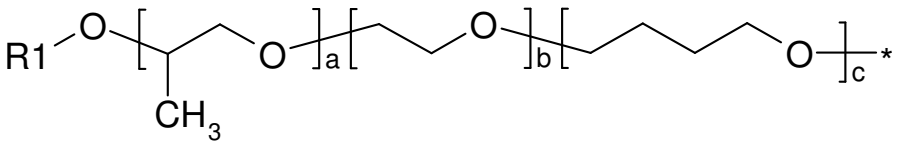
wherein R2 represents an optionally substituted hydrocarbon residue consisting of 1 to 100 carbon atoms.

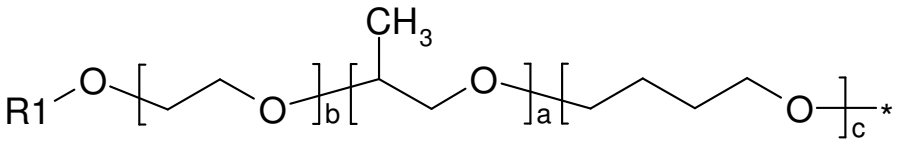
5. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein end-caps are described by the following general formula

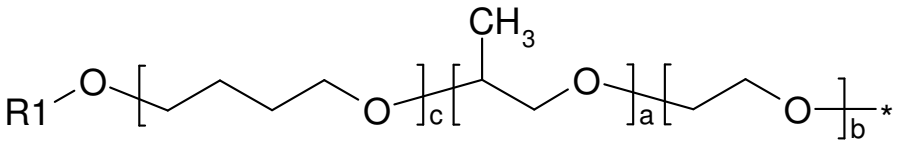
$$R1\text{-}O\text{-}(C_2\text{-}C_4\text{-}O\text{-})_e\text{-}*,$$

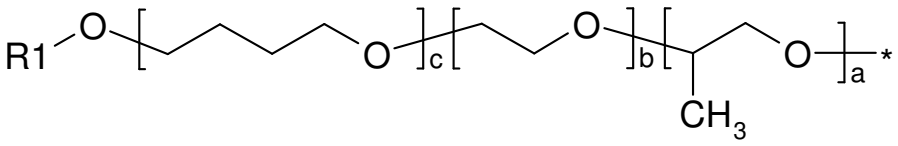
wherein R1 is an aliphatic hydrocarbon residue of 1 to 24 carbon atoms, an olefinic hydrocarbon residue of 2 to 24 carbon atoms, an aromatic hydrocarbon residue of 6 to 14 carbon atoms, wherein said hydrocarbon residues are optionally substituted with C_1-C_5-alkoxy, nitro, cyano, sulfo, or a combination thereof, and e is an integer of between 0 and 500.

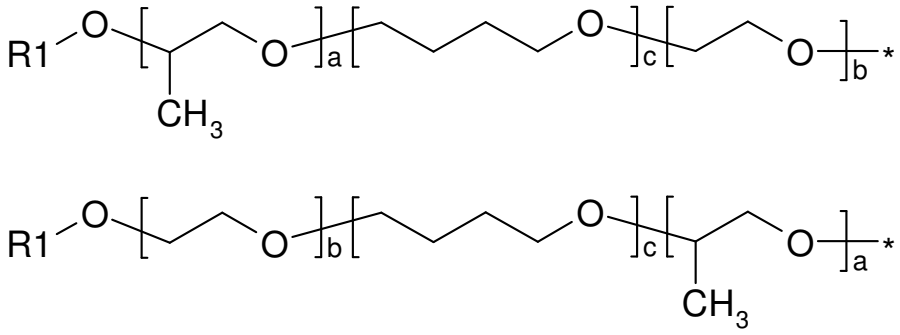
6. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein R1-$(C_2$-C_4-O-$)_e$-* correspond to the following formulae











wherein the different monomers are distributed randomly, in blocks or a combination of random and block, and

b is an integer between 0 and 250,

a is an integer between 0 and 250,

c is an integer between 0 and 70,

and the sum a+b+c is of from 0 to 570; and

R1 is as defined in claim 5.

7. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein R1 denotes methyl, ethyl, n-propyl, iso-propyl, n-butyl, iso-butyl, sec-butyl, tert-butyl, n-pentyl, iso-pentyl, sec-pentyl, neo -pentyl, 1,2-dimethylpropyl, iso-amyl, n-hexyl, sec-hexyl, n-heptyl, n-octyl, 2-ethyl-hexyl, n-nonyl, n-decyl, tridecyl, isotridecyl, tetradecyl, hexadecyl, octadecyl, methylphenyl cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, cycloheptyl, cyclooctyl, cyclononyl, or cyclodecyl.

8. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein the number average of the molecular weight is between 2000 and 1000000 g/mol.

9. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein the mass ratio Ω, defined as the mass ratio between the poly(tetramethyleneoxide) content and the overall content of all dicarbonyl structure elements (ii) and (iii) is between 0.1 and 10.

10. The polyether-polyester copolymer as claimed in any of the preceding claims, wherein the mass ratio Θ, defined as the mass ratio between the endcap content and the overall content of all dicarbonyl structure elements (ii) and (iii) is between 0.001 and 100.

11. A method of preparing a polyether-polyester copolymer as claimed in any of the preceding claims comprising a polycondensation of the polyether segments containing at least one polytetramethylenoxide segment, the polyester segments, the bridging elements and the end-caps.

12. An active oxygen barrier composition comprising a polyether-polyester copolymer as claimed in claims 1 to 10 and a transition metal catalyst.

13. A plastic material comprising:

a component a) which is a thermoplastic polymer;

a component b) which is a polyether-polyester copolymer as claimed in any of claims 1 to 10; and

a component c) which is a transition metal catalyst.

14. The plastic material as claimed in claim 13, which is a masterbatch, a compound or a formed article.

15. The plastic material as claimed in claims 13 or 14 which is or is part of a container or a film.