However, like the copolymerization strategy, polymer blends are often accompanied by a marked loss in stiffness, because the blended materials may have lower elastic modulus than the matrix polyolefin.

**[0007]** Accordingly, there exists a continuing need for developments in polyolefin compositions to have increases in environmental stress cracking resistance while balancing the mechanical properties of the polymer. There also exists a continuing need for polyolefin compositions having good barrier properties to various gases and volatile organic compounds.

## SUMMARY OF INVENTION

**[0008]** This summary is provided to introduce a selection of concepts that are described further below in the detailed description. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used as an aid in limiting the scope of the claimed subject matter.

**[0009]** In one aspect, the present disclosure provides a polymer composition that may include a polymer matrix containing a polyolefin, one or more polymer particles dispersed in the polymer matrix, wherein the one or more polymer particles include a polar polymer selectively crosslinked with a crosslinking agent, and wherein the one or more polymer particles has an average particle size of up to 200 μm, wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine, epoxy, imide, imine, sulfone, phosphone and their derivatives; and wherein the polymer matrix further comprises a functionalized polyolefin.

[0009a] In another aspect, the present disclosure provides a polymer composition comprising a polymer matrix comprising a polyolefin; one or more polymer particles dispersed in the polymer matrix, the one or more polymer particles comprising a polar polymer reacted with a crosslinking agent to form a crosslinked polar polymer, wherein the crosslinking agent reacts selectively with one or more functional groups present on the polar polymer, and wherein the polar polymer is crosslinked in the presence of the polymer matrix, wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine,

epoxy, imide, imine, sulfone, phosphone and their derivatives; and wherein the polymer matrix further comprises a functionalized polyolefin.

[0009b] In another aspect, the present disclosure provides a manufactured article comprising the polymer composition as mentioned above.

**[0010]** In another aspect, the present disclosure provides a process of preparing a polymer composition as mentioned above which may include mixing a polyolefin, a functionalized polyolefin, a polar polymer, and a crosslinking agent; and selectively crosslinking the polar polymer with the crosslinking agent in the presence of the polyolefin.

[0010a] In another aspect, the present disclosure provides a polymer blend composition composition prepared according to the process as described herein.

[0010b] In another aspect, the present disclosure provides a masterbatch comprising the polymer blend composition as described herein.

[0010c] In another aspect, the present disclosure provides a manufactured article comprising the polymer blend composition as described herein.

**[0011]** In another aspect, the present disclosure provides a method that may include increasing stress cracking resistance of a polyolefin by mixing a polar polymer with the polyolefin and a functionalized polyolefin; and selectively crosslinking the polar polymer in the presence of the polyolefin with a crosslinking agent to form crosslinked polar polymer particles dispersed in the polyolefin, wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine, epoxy, imide, imine, sulfone, phosphone and their derivatives.

**[0012]** Other embodiments and advantages of the disclosure will be apparent from the following description and the appended claims.

# CLAIMS

1. A polymer composition comprising:

   a polymer matrix comprising a polyolefin;

   one or more polymer particles dispersed in the polymer matrix, wherein the one or more polymer particles comprise a polar polymer selectively crosslinked with a crosslinking agent, wherein the one or more polymer particles has an average particle size of up to 200 μm, and wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine, epoxy, imide, imine, sulfone, phosphone and their derivatives; and

   wherein the polymer matrix further comprises a functionalized polyolefin.

2. The polymer composition of claim 1, wherein the one or more polymer particles has an average particle size of up to 50 μm.

3. The polymer composition of claims 1 or 2, wherein the polyolefin is present in a range of 30 wt% to 99.9 wt%.

4. The polymer composition of any of the above claims, wherein the polyolefin is present in a range of 90 wt% to 99 wt%.

5. The polymer composition of any of the above claims, wherein the polyolefin comprises one or more polymers selected from a group consisting of ethylene homopolymers, copolymers of ethylene and one or more C3-C20 alpha-olefins, propylene homopolymers, copolymers of propylene and one or more comonomers selected from ethylene or C4-C20 alpha-olefins, heterophasic propylene polymers, olefin terpolymers, and blends thereof.

6. The polymer composition of any of the above claims, wherein the polar polymer has a weight average molecular weight of 5,000 to 300,000 g/mol.

7. The polymer composition of any of the above claims, wherein the polar polymer is selected from the group consisting of polyvinyl alcohol, ethylene vinyl alcohol copolymer, ethylene vinyl acetate copolymer and mixtures thereof.

8. The polymer composition of claim 6, wherein the polar polymer is polyvinyl alcohol having a hydrolysis degree in the range of 30% to 100%.

9. The polymer composition of any of the above claims, wherein the crosslinking agent is selected from the group consisting of maleic anhydride, maleic acid, itaconic acid, itaconic anhydride, succinic acid, succinic anhydride, succinic aldehyde, adipic acid, adipic anhydride, phthalic anhydride, pthalic acid, glutaraldehyde, their derivatives and mixtures thereof.

10. The polymer composition of any of the above claims, further comprising a filler or a nanofiller.

11. The polymer composition of claim 10, wherein the filler or the nanofiller is present in the range of 0.001 wt% to 5 wt%.

12. The polymer composition of claim 1, wherein the functionalized polyolefin is present in the range of 0.1 wt% to 15 wt%, based in the total mass of the polymer composition.

13. The polymer composition of claim 1, wherein the functionalized polyolefin is a polyolefin functionalized with one or more selected from a group consisting of maleic anhydride, maleic acid, acrylic acid, methacrylic acid, itaconic acid, itaconic anhydride,

methacrylate, acrylate, epoxy, silane, succinic acid, succinic anhydride, ionomers, and their derivatives.

14. The polymer composition of any of the above claims, wherein the polymer composition presents a Normalized Property Balance Index ($N_{PBI}$) within the range of 1.5 to 10, wherein the $N_{PBI}$ is calculated according to the formula:

$$N_{PBI} = \frac{PBI_{sample}}{PBI_{reference}},$$

where $PBI_{Sample}$ is the property balance index for a sample of the polymer composition, and $PBI_{Reference}$ is the property balance index of a reference polymer composition consisting of the polyolefin; and wherein PBI is calculated according to the formula:

$$PBI = \frac{FM \times IR \times ESCR}{10^7},$$

where FM is the stiffness of the sample as determined by secant modulus of elasticity at 1% deformation according to ASTM D-790, IR is the IZOD impact resistance according to ASTM D-256, and ESCR is the environmental stress cracking resistance according to ASTM D-1693.

15. The polymer composition of any of the above claims, wherein the polymer composition presents up to 60% increase in barrier to oxygen when compared to a reference polyolefin according to ASTM-1927.

16. The polymer composition of any of the above claims, wherein the polymer composition presents up to 60% increase in barrier to volatile organic compounds (VOC) when compared to a reference polyolefin.

17. A polymer composition comprising:

a polymer matrix comprising a polyolefin;

one or more polymer particles dispersed in the polymer matrix, the one or more polymer particles comprising a polar polymer reacted with a crosslinking agent to form a crosslinked polar polymer, wherein the crosslinking agent reacts selectively with one or more functional groups present on the polar polymer, and wherein the polar polymer is crosslinked in the presence of the polymer matrix, wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine, epoxy, imide, imine, sulfone, phosphone and their derivatives; and

wherein the polymer matrix further comprises a functionalized polyolefin.

18. A manufactured article comprising the polymer composition of any of the above claims.

19. A process for preparing the polymer composition of any one of claims 1, 5-7 and 9, the process comprising:

mixing a polyolefin, a functionalized polyolefin, a polar polymer, and a crosslinking agent; and

selectively crosslinking the polar polymer with the crosslinking agent in the presence of the polyolefin.

20. The process of claim 19, wherein the mixing comprises mixing the polyolefin, the functionalized polyolefin and the one or more polar polymer to form a first mixture, and subsequently adding the crosslinking agent to the first mixture.

21. The process of claims 19 or 20, wherein mixing is performed by solubilization or extrusion.

22. The process of any of claims 19-21, wherein the crosslinking agent is added at a concentration ranging from 0.001 wt% to 10 wt%.

23. The process of any of claims 19-22, wherein the functionalized polyolefin is a polyolefin functionalized with one or more selected from a group consisting of maleic anhydride, maleic acid, acrylic acid, methacrylic acid, itaconic acid, itaconic anhydride, methacrylate, acrylate, epoxy, silane, succinic acid, succinic anhydride, and ionomers.

24. The process of any of claims 19-23, further comprising mixing a filler or a nanofiller with the polyolefin, the functionalized polyolefin, the polar polymer, and the crosslinking agent.

25. A polymer blend composition prepared according to the process of any of claims 19 to 24.

26. A masterbatch comprising the composition of claim 25.

27. A manufactured article comprising the polymer blend composition of claim 25.

28. The manufactured article of claim 18 or 27, wherein the article is an injection molded article, a thermoformed article, a film, a foam, a blow molded article, a rotomolded article, extruded article, or a pultruded article.

29. A method of increasing stress cracking resistance of a polyolefin comprising:

mixing a polar polymer with a polyolefin and a functionalized polyolefin; and

selectively crosslinking the polar polymer in the presence of the polyolefin with a crosslinking agent to form crosslinked polar polymer particles dispersed in the polyolefin, wherein the polar polymer comprises at least one functional group selected from the group consisting of hydroxyl, carboxylic acid, carboxylate, ester, ether, acetate, amide, amine, epoxy, imide, imine, sulfone, phosphone and their derivatives.