CLAIMS

1. A process for polymerizing ethylene-based polymers, the process comprising:

polymerizing ethylene and optionally one or more (C_3-C_{14})α-olefin monomer, and at least one diene, in the presence of at least one multi-chain catalyst and at least one single-chain catalyst and optionally a solvent, wherein the multi-chain catalyst comprises a plurality of polymerization sites; and

synthesizing long-chain branched polymers by connecting the two polymer chains of the multi-chain catalyst with the diene, the joining of the two polymer chains being performed in a concerted manner during the polymerization; and

producing the ethylene based polymer comprising at least two molecular weight polymer fractions, wherein the multi-chain catalyst produces the high molecular weight fraction which is the long-chain branched polymer.

2. The process of claim 1, wherein the diene is unconjugated and acyclic.

~~3. The process of claim 2, wherein the diene is acyclic.~~

~~4~~3. The process of claim ~~3~~1, wherein the diene comprises 1,4-pentadiene, 1,5-hexadiene, 1,6-heptadiene, 1,7-octadiene, 1,8-nonadiene, 1,9-decadiene, 1,10-undecadiene, 1,11-dodecadiene, dimethyldivinylsilane, dimethyldiallylsilane, dimethylallylvinylsilane.

~~5. The process of any one of the preceding claims, wherein the multi-chain catalyst has two ligated transition metals linked by a dianionic activator where the distance between the metal atoms is less than or equal to 18.5 Å.~~

~~6. The process of any one of the preceding claims, wherein the multi-chain catalyst consists of two or more transition metals covalently tethered, where the distance between the metal atoms is less than or equal to 18.5 Å.~~

~~7~~4. The process of any one of the preceding claims, wherein the active multi-chain catalyst has two or more polymer chains on the same metal.

~~8~~5. The process of claim ~~7~~4, wherein the active multi-chain catalyst comprises a monoanionic ligand, a Group IV Metal (Ti, Zr, Hf), and has two polymer chains on the same metal.

~~9~~6. The process of any one of the preceding claims, wherein the process further comprises polymerizing the one or more (C_3-C_{14})α-olefin monomers and the at least one diene in a solution polymerization reactor in the presence of a solvent.

~~10~~7. The process of according to claim ~~9~~6, wherein the solution reactor is a batch reactor, a continuous reactor, or a hybrid reactor.

~~11~~8. The process of any one of the preceding claims, wherein the process further comprises polymerizing one or more (C_3-C_{14})α-olefin monomers and at least one diene.

~~12~~9. The process of any one of the preceding claims, wherein the ethylene-based polymer comprises:

a low molecular weight polymer fraction and a high molecular weight polymer fraction, which are divided by S_{max} on a molecular weight distribution (MWD) curve determined via absolute gel permeation chromatography, wherein S_{max} is the maximum absolute slope on the higher molecular weight side of the primary peak of the MWD curve, wherein the primary peak is the peak of greatest magnitude in the MWD curve;

wherein the low molecular weight polymer fraction and the high molecular weight polymer fraction each comprise a Ladder character, L, defined for a given absolute molecular weight (MW) as the fit of the log of the intrinsic viscosity [η] versus the log of the absolute MW (M) curve using the expression, $\log[\eta] = \log(\beta) + \alpha\log(M) - L*\alpha\log(2)$ according to a Mark-Houwink-Sakurada curve, wherein log(β) is the intercept and α is the slope, and wherein

the low molecular weight polymer fraction has an MW below S_{max} and all values of L between −0.35 to 0.35; and

the high molecular weight polymer fraction has an MW above S_{max} and a maximum value of L between 0.8 and 1.5.

~~13~~10. The process of any one of the preceding claims, wherein the ethylene-based polymer comprises:

a melt viscosity ratio ($V_{0.1}/V_{100}$) at 190 °C greater than 20, where $V_{0.1}$ is the viscosity of the ethylene-based polymer at 190 °C at a frequency of 0.1 radians/second, and V_{100} is the viscosity of the ethylene-based polymer at 190 °C at a frequency of 100 radians/second; and

an average g' greater than 0.86, where the average g' is an intrinsic viscosity ratio determined by gel permeation chromatography using a triple detector.

~~14~~11. The process of any one of the preceding claims, wherein the ethylene-based polymer comprises:

a melt strength greater than 10 cN (Rheotens device, 190°C, 2.4 mm/s^2, 120 mm from the die exit to the center of the wheels, extrusion rate of 38.2 s^{-1}, capillary die of 30 mm length, 2 mm diameter and 180° entrance angle); and

an average g' greater than 0.86, where the average g' is an intrinsic viscosity ratio determined by gel permeation chromatography using a triple detector.

~~15~~12. The process of any one of the preceding claims, wherein the ethylene-based polymer comprises:

a melt strength (MS) > -17 * log (MI) + 25, wherein MS is the melt strength in cN (Rheotens device, 190°C, 2.4 mm/s^2, 120 mm from the die exit to the center of the wheels, extrusion rate of 38.2 s^{-1}, capillary die of 30 mm length, 2 mm diameter and 180° entrance angle) and MI is the melt index in g/10min according to ASTM D1238.

~~16~~13. The process of any one of the preceding claims, wherein the ethylene-based polymer has a weight averaged molecular weight (M_w) of less than or equal to 250,000 Daltons, as determined by absolute gel permeation chromatography.

~~17. The process of claim 16, wherein the ethylene-based polymer has a weight averaged molecular weight (M_w) of less than or equal to 150,000 Daltons, as determined by absolute gel permeation chromatography.~~

~~18. The process of claim 17, wherein the ethylene-based polymer has a weight averaged molecular weight (M_w) of less than or equal to 100,000 Daltons, as determined by absolute gel permeation chromatography.~~

~~19~~14. The process of any one of the preceding claims, wherein the MI is greater than 0.1, wherein MI is the melt index in g/10min according to ASTM D1238.

~~20. The process of claim 19, wherein the MI is greater than 1, wherein MI is the melt index in g/10min according to ASTM D1238.~~

~~21~~15. The process of claim ~~20~~14, wherein the MI is greater than 2, wherein MI is the melt index in g/10min according to ASTM D1238.

~~22. The process of claim 21, wherein the MI is greater than 3, wherein MI is the melt index in g/10min according to ASTM D1238.~~