EP 1260540 and EP 1225201 similarly disclose polymers having DRI of at least $8/MI_2$ and $5/MI_2$ respectively.

US 5674342 describes ethylene polymers having a DRI of at least 0.1 and preferably at least 0.3 and a melt flow ratio ($I_{10}/I_2$) in the range 8 to about 12. Specifically exemplified polymers exhibit DRI in the range 0.3 – 0.7 and molecular weight distributions (Mw/Mn) in the range 2.15 - 3.4.

WO 04/000919 describes films from LLDPE having a ratio of MD tear to TD tear of ≥ 0.9. The films are based on copolymers produced from hafnium metallocene catalysts systems, the reported films however have dart impacts of ≤ 690 g (1013 g/mil).

WO 06/085051 describes copolymers of ethylene and alpha-olefins having broader molecular weight distributions (Mw/Mn) in the range 3.5 to 4.5. These copolymers exhibited a melt elastic modulus G' (G''= 500 Pa) in the range 40 to 150 Pa and an activation energy of flow (Ea) in the range 28 – 45 kJ/mol but which had low or moderate amounts of LCB.

WO 08/074689 describes copolymers of ethylene and alpha-olefins having a much lower Dow Rheology Index (DRI) but with a more balanced processability with improved properties particularly those suitable for preparing films with an excellent balance of processing, optical and mechanical properties.

The copolymers described and exemplified in these prior art publications have typically been copolymers of ethylene and α-olefins having C4 – C6 carbon atoms for example 1-butene, 1-hexene and 4-methyl-1 pentane.

## SUMMARY

We have now surprisingly found that copolymers comprising ethylene and higher α-olefins, in particular having C7 to C12 carbon atoms and most preferably having C8 carbon atoms, show improved processability having properties particularly suitable for preparing films with an excellent balance of processing, optical and mechanical properties. In particular blown films exhibit an excellent combination of MD tear strength, TD tear strength and dart drop impact.

Thus according to a first aspect of the present ~~invention~~disclosure there is provided a copolymer of ethylene and a α-olefin having C7 to C12 carbon atoms, said copolymer having

(a) a density (D) in the range 0.900 – 0.940 g/cm$^3$,

(b) a melt index $MI_2$ (2.16 kg, 190°C) in the range of 0.01 - 50 g/10 min,

(c) a melt elastic modulus G' (G''= 500 Pa) in the range 20 to 150 Pa, and

(d) a tear strength (MD) of ≥ 220 g

a tear strength (TD) of ≥ 470g, and

a Dart Drop Impact (DDI) of ≥ 1800g

of a blown film having a thickness of 25 μm produced from the copolymer, where MD is referred to the machine direction and TD is the transverse direction of the blown film.

For the avoidance of doubt all references to density refer to the non-annealed density unless otherwise stated.

According to another aspect, there is provided a film comprising a copolymer of ethylene and an α-olefin having C7 to C12 carbon atoms as defined above.

According to another aspect, there is provided a blown film comprising a copolymer of ethylene and an α-olefin having C7 to C12 carbon atoms, said copolymer having

(a) a density in the range 0.900 – 0.940 g/cm$^3$,

(b) a melt index $MI_2$ (2.16 kg, 190°C) in the range of 0.01 - 50 g/10 min, and

(c) a melt elastic modulus G' (G''= 500 Pa) in the range 20 to 150 Pa

wherein said film when having a thickness of 25 μm exhibits :

a tear strength (MD) of ≥ 220 g

a tear strength (TD) of ≥ 470 g, and

a Dart Drop Impact (DDI) ≥ 1800 g

wherein MD is referred to the machine direction and TD is the transverse direction of the film.

DETAILED DESCRIPTION

The novel copolymers of the present invention may also be suitably described by reference to the relationship between density (D) and the Dart Drop Impact (DDI).

Thus according to another aspect of the present invention there is provided a copolymer of ethylene and a α-olefin having C7 to C12 carbon atoms, said copolymer having

(a) a density (D) in the range 0.900 – 0.940 g/cm$^3$,

(b) a melt index $MI_2$ (2.16 kg, 190°C) in the range of 0.01 - 50 g/10 min,

(c) a tear strength (TD) of ≥ 470g, and a Dart Drop Impact (DDI) in g of a blown film having a thickness of 25 μm produced from the copolymer satisfying the equation:

$$DDI \geq 21500 \times \{1 - Exp [-750(D - 0.908)^2]\} \times \{Exp [(0.919 - D)/0.0045]\}$$

The novel polymers of the present invention may also be defined by means of their Composition Distribution Breadth Index (CDBI) which has been well defined, for example in US 5206075 and PCT publication WO93/03090, as a measure of the composition distribution. The CDBI may be suitably determined by means of Temperature Rising Elution Fractionation (TREF).

The novel copolymers of the present invention exhibit a relationship between the Composition Distribution Breadth Index (CDBI) and density (D) that satisfy the relationship of

$$CDBI \leq (- 192 \mathbf{D} + 241.5)$$

The novel copolymers of the present invention typically exhibit a CDBI in the range 50 – 63%.