



US005733653A

United States Patent [19][11] **Patent Number:** 5,733,653

Cuculo et al.

[45] **Date of Patent:** Mar. 31, 1998

[54] **ULTRA-ORIENTED CRYSTALLINE FILAMENTS AND METHOD OF MAKING SAME**

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[21] **Appl. No.:** 643,925

[22] **Filed:** May 7, 1996

[51] **Int. Cl.⁶** D02G 3/00

[52] **U.S. Cl.** 428/364; 428/395

[58] **Field of Search** 428/364, 395

[56] **References Cited****U.S. PATENT DOCUMENTS**

3,002,804	10/1961	Kilian .
4,134,882	1/1979	Frankfort et al. .
4,425,293	1/1984	Vassilatos .
4,446,299	5/1984	Koschinek et al. .
4,835,053	5/1989	Stanko .
4,909,976	3/1990	Cuculo et al. .
4,975,326	12/1990	Buyalos et al. .
5,019,316	5/1991	Ueda et al. .
5,033,523	7/1991	Buyalos et al. .
5,049,447	9/1991	Shindo et al. .

5,137,670	8/1992	Murase et al. .
5,149,480	9/1992	Cuculo et al. .
5,171,504	12/1992	Cuculo et al. .
5,182,068	1/1993	Richardson .
5,186,879	2/1993	Simons et al. .
5,234,764	8/1993	Nelson et al. .
5,268,133	12/1993	Cuculo et al. .
5,405,696	4/1995	Cuculo et al. .
5,486,416	1/1996	Johnson et al. 428/357

FOREIGN PATENT DOCUMENTS

670932 9/1963 Canada .

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[57] **ABSTRACT**

Ultra-oriented, crystalline synthetic filaments with a combination of high tenacity, high dimensional stability, high modulus, and a high fraction of taut-tie molecular phase are produced by extruding a fiber-forming synthetic polymer melt into a liquid isothermal bath, withdrawing the filaments from the bath and then post-treating them at a very low draw ratio. The bath is preferably maintained at a temperature of at least 30° C. above the glass transition temperature of the polymer to enhance the orientation and promote the formation of stable extended chains. Polymer filaments so produced are characterized in that they have ultra-high birefringence, high tenacity and modulus, a high dimensional stability, and a high fraction of taut-tie molecular phase.

10 Claims, 8 Drawing Sheets