



US009409347B2

(12) **United States Patent**  
**Nelson et al.**

(10) **Patent No.:** **US 9,409,347 B2**  
(45) **Date of Patent:** **Aug. 9, 2016**

(54) **METHOD FOR FORMING REINFORCED PULTRUDED PROFILES**

(75) Inventors: **Sherri M. Nelson**, Winona, MN (US);  
**David W. Eastep**, Winona, MN (US);  
**Timothy A. Regan**, Winona, MN (US)

(73) Assignee: **Ticona LLC**, Florence, KY (US)

(\* ) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 449 days.

(21) Appl. No.: **13/697,404**

(22) PCT Filed: **Jun. 22, 2011**

(86) PCT No.: **PCT/US2011/041433**

§ 371 (c)(1),  
(2), (4) Date: **Feb. 12, 2013**

(87) PCT Pub. No.: **WO2011/163349**

PCT Pub. Date: **Dec. 29, 2011**

(65) **Prior Publication Data**

US 2013/0149521 A1 Jun. 13, 2013

**Related U.S. Application Data**

(60) Provisional application No. 61/357,289, filed on Jun. 22, 2010.

(51) **Int. Cl.**

**B32B 1/00** (2006.01)

**B29C 70/08** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ..... **B29C 70/08** (2013.01); **B29C 70/081** (2013.01); **B29C 70/52** (2013.01); **B29C 70/521** (2013.01); **B29C 70/525** (2013.01); **B29B 15/122** (2013.01); **Y10T 428/249921** (2015.04)

(58) **Field of Classification Search**

CPC ..... B29C 70/52; B29C 70/08

USPC ..... 264/135, 137; 428/292.1, 297.4

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,669,158 A 6/1972 Phillips

4,394,338 A 7/1983 Fuwa

(Continued)

FOREIGN PATENT DOCUMENTS

DE 102007018052 10/2008

EP 0155552 9/1985

(Continued)

*Primary Examiner* — Galen Hauth

(74) *Attorney, Agent, or Firm* — Dority & Manning, P.A.

(57) **ABSTRACT**

A method and apparatus for forming a profile that contains at least one layer of continuous fibers and at least one layer of discontinuous fibers. Said method allowing the selective control of features to achieve a profile that has increased transverse strength and flexural modulus. The layer of continuous fibers may be formed from one or more continuous fiber reinforced ribbons (“CFRT”) (12) that contain fibers embedded within a thermoplastic polymer matrix, whereby a void fraction and in turn is minimized and flexural modulus is optimized. Further, the ribbon (s) are consolidated so that the continuous fibers remain fixed in alignment in a substantially longitudinal direction (e.g., the direction of pultrusion). In addition to enhancing the tensile properties of the profile, the use of such ribbons also allows an improved handability when placing them into the desired position within the pultrusion die. The discontinuous fibers are also embedded within a thermoplastic matrix, in such a way as to assist in bonding of the layers to achieve the desired strength. At least a portion of the fibers are oriented in the transverse direction to provide increased transverse strength.

**31 Claims, 16 Drawing Sheets**

