



(51) International Patent Classification:

*B32B 5/02* (2006.01)      *B32B 5/26* (2006.01)  
*B32B 5/06* (2006.01)      *F41H 5/04* (2006.01)  
*B32B 5/12* (2006.01)

(21) International Application Number:

PCT/US2022/079140

(22) International Filing Date:

02 November 2022 (02.11.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

63/277,802      10 November 2021 (10.11.2021) US

(71) Applicant: **DUPONT SAFETY & CONSTRUCTION, INC.** [US/US]; 974 Centre Road, Wilmington, Delaware 19805 (US).

(72) Inventors: **HOVANEK, Joseph**; 5401 Jefferson Davis Highway, Richmond, Virginia 23234 (US). **JANCO, Scott**; 5401 Jefferson Davis Highway, Richmond, Virginia 23234 (US). **SHAHKARAMI, Shekoufeh**; 6925 Century Ave.,

Suite 700, Mississauga, Ontario L5N 7K2 (CA). **MULCAHY, Kevin**; 5401 Jefferson Davis Highway, Richmond, Virginia 23234 (US).

(74) Agent: **GOMBITA, Stephen J.**; 974 Centre Road, Wilmington, Delaware 19805 (US).

(81) Designated States (*unless otherwise indicated, for every kind of national protection available*): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ,

(54) Title: BALLISTIC RESISTANT MATERIAL MADE OF MECHANICALLY ENTANGLED WOVEN FABRICS WITHOUT NONWOVEN FIBERS AND METHOD OF MAKING THEREOF

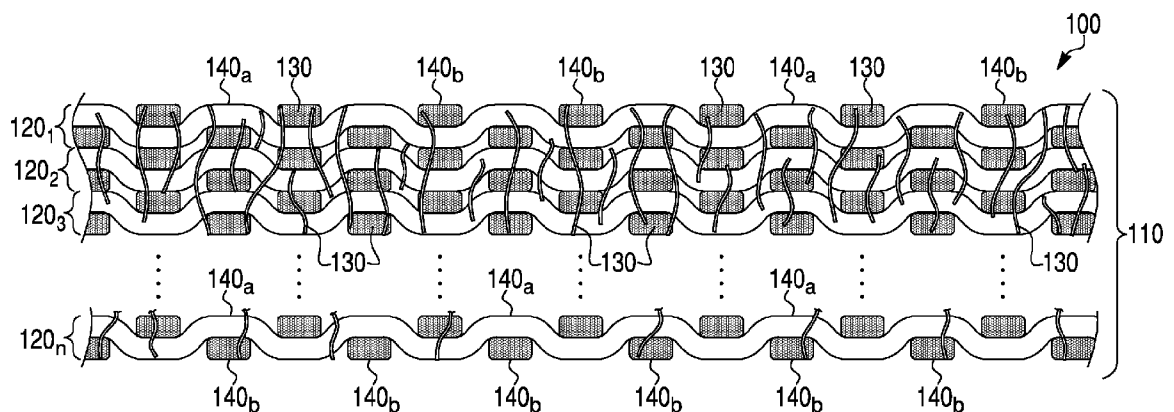


FIG. 1

(57) Abstract: A consolidated material and method for forming a consolidated material. The consolidated material comprises a plurality of woven fabric layers that are mechanically entangled together. The plurality of woven fabric layers comprise fibers. The plurality of woven fabric layers are mechanically entangled together with fibers of the plurality of woven fabric layers and without nonwoven fibers. At least some fibers of the plurality of woven fabric layers extend in the Z-direction perpendicular to the x-y plane of the plurality of woven fabric layers. Methods for forming a consolidated material are also provided.



RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

**Published:**

- *with international search report (Art. 21(3))*
- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

**(88) Date of publication of the international search report:**

28 December 2023 (28.12.2023)

**INTERNATIONAL SEARCH REPORT**

International application No  
**PCT/US2022/079140**

**A. CLASSIFICATION OF SUBJECT MATTER**  
**INV. B32B5/02 B32B5/06 B32B5/12 B32B5/26 F41H5/04**  
**ADD.**

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**  
 Minimum documentation searched (classification system followed by classification symbols)  
**B32B**

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)  
**EPO-Internal**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
<b>X</b>	<b>US 2014/272267 A1 (GRUNDEN BRADLEY [US] ET AL) 18 September 2014 (2014-09-18) paragraphs [0002] - [0004], [0021], [0050], [0051], [0030], [0038], [0041], [0031]; claim 19</b> -----	<b>1-20</b>
<b>X</b>	<b>US 2014/206248 A1 (VITO ROBERT A [US]) 24 July 2014 (2014-07-24) paragraphs [0002] - [0004], [0013], [0037], [0042]; figure 3</b> -----	<b>1-20</b>
<b>X</b>	<b>US 2012/312151 A1 (PATEL CHINKALBEN [CA]) 13 December 2012 (2012-12-13) paragraphs [0002], [0003], [0028], [0041], [0042]</b> -----	<b>1-20</b>

Further documents are listed in the continuation of Box C.       See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"E" earlier application or patent but published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search  <b>7 November 2023</b>	Date of mailing of the international search report  <b>16/11/2023</b>
---	---

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer  <b>Aspeby, Erika</b>
--	--

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No <b>PCT/US2022/079140</b>
--

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
<b>US 2014272267 A1</b>	<b>18-09-2014</b>	<b>BR 112015023688 A2</b>	<b>18-07-2017</b>
		<b>CA 2908557 A1</b>	<b>11-12-2014</b>
		<b>CN 105190222 A</b>	<b>23-12-2015</b>
		<b>EP 2972058 A2</b>	<b>20-01-2016</b>
		<b>ES 2730712 T3</b>	<b>12-11-2019</b>
		<b>JP 6427165 B2</b>	<b>21-11-2018</b>
		<b>JP 2016517500 A</b>	<b>16-06-2016</b>
		<b>KR 20150141184 A</b>	<b>17-12-2015</b>
		<b>RU 2015144365 A</b>	<b>24-04-2017</b>
		<b>TR 201909983 T4</b>	<b>21-08-2019</b>
		<b>US 2014272267 A1</b>	<b>18-09-2014</b>
		<b>WO 2014197039 A2</b>	<b>11-12-2014</b>
		-----	
<b>US 2014206248 A1</b>	<b>24-07-2014</b>	<b>CA 2887548 A1</b>	<b>24-04-2014</b>
		<b>EP 2909025 A1</b>	<b>26-08-2015</b>
		<b>TW 201418538 A</b>	<b>16-05-2014</b>
		<b>US 2014206248 A1</b>	<b>24-07-2014</b>
		<b>WO 2014062414 A1</b>	<b>24-04-2014</b>
-----			
<b>US 2012312151 A1</b>	<b>13-12-2012</b>	<b>BR 112012020694 A2</b>	<b>26-07-2016</b>
		<b>EP 2529176 A1</b>	<b>05-12-2012</b>
		<b>KR 20120135510 A</b>	<b>14-12-2012</b>
		<b>US 2012312151 A1</b>	<b>13-12-2012</b>
		<b>WO 2011100831 A1</b>	<b>25-08-2011</b>
		<b>WO 2011100832 A1</b>	<b>25-08-2011</b>
-----			