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## Patent Public Search | Text View

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United States Patent	12390075
Kind Code	B2
Date of Patent	August 19, 2025
Inventor(s)	Policicchio; Nicola John

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### Cleaning article with double bonded tow tufts

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#### Abstract

A cleaning article defining an XY plane and a Z direction perpendicular to the plane. The cleaning article has discrete tufts of tow fibers disposed on a carrier sheet. The discrete tufts have bond lines external to the tufts. The bond lines interrupt the Z-direction thickness of the tufts, to provide channels for improved collection and retention of debris from a target surface.

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<b>Appl. No.:</b>	<b>18/407859</b>
<b>Filed:</b>	<b>January 09, 2024</b>

#### Prior Publication Data

<b>Document Identifier</b>	<b>Publication Date</b>
US 20240138647 A1	May. 02, 2024

#### Related U.S. Application Data

continuation parent-doc US 15943739 20180403 US 11903542 child-doc US 18407859

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#### Publication Classification

**Int. Cl.:** A47L13/16 (20060101); A47L13/20 (20060101); A47L13/38 (20060101); B32B5/02 (20060101); B32B5/26 (20060101); D04H1/435 (20120101); D04H11/00 (20060101)

**U.S. Cl.:**

CPC      **A47L13/16** (20130101); **A47L13/38** (20130101); **D04H1/435** (20130101); A47L13/20 (20130101); B32B5/022 (20130101); D04H11/00 (20130101)

## Field of Classification Search

**CPC:**      A47L (13/16); A47L (13/20); A47L (13/38); Y10T (428/23907); Y10T (428/23929); Y10T (428/23936); B32B (2432/00); B32B (5/022); B32B (5/26); B32B (5/266); B32B (3/10); B32B (3/263); D04H (11/00)

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## References Cited

### U.S. PATENT DOCUMENTS

Patent No.	Issued Date	Patentee Name	U.S. Cl.	CPC
823725	12/1905	Hayden	N/A	N/A
4145787	12/1978	Bastian	N/A	N/A
5691035	12/1996	Chappell et al.	N/A	N/A
6143393	12/1999	Abe et al.	N/A	N/A
6241835	12/2000	Abe et al.	N/A	N/A
6245413	12/2000	Kenmochi et al.	N/A	N/A
6319593	12/2000	Kenmochi et al.	N/A	N/A
6329308	12/2000	Kenmochi et al.	N/A	N/A
6550092	12/2002	Brown et al.	N/A	N/A
6554937	12/2002	Kenmochi et al.	N/A	N/A
6774070	12/2003	Kenmochi et al.	N/A	N/A
6777064	12/2003	Brown et al.	N/A	N/A
6797357	12/2003	Fereshtehkhrou et al.	N/A	N/A
6813801	12/2003	Tanaka et al.	N/A	N/A
6936330	12/2004	Fereshtehkhrou et al.	N/A	N/A
6984615	12/2005	Kenmochi et al.	N/A	N/A
7003856	12/2005	Hayashi et al.	N/A	N/A
7291359	12/2006	Haskett et al.	N/A	N/A
7302729	12/2006	Tanaka	N/A	N/A
7386907	12/2007	Otsuka et al.	N/A	N/A
7560398	12/2008	Zillig et al.	N/A	N/A
7566671	12/2008	Hoadley et al.	N/A	N/A
7682686	12/2009	Curro et al.	N/A	N/A
7712178	12/2009	Yamada	N/A	N/A
7779502	12/2009	Fujiwara et al.	N/A	N/A
7786030	12/2009	Tsuchiya	N/A	N/A
7803726	12/2009	Policicchio et al.	N/A	N/A
7838099	12/2009	Curro et al.	N/A	N/A
7870635	12/2010	Yamada	N/A	N/A
7937797	12/2010	Tsuchiya et al.	N/A	N/A
8075977	12/2010	Curro et al.	N/A	N/A
8146197	12/2011	Yamada	N/A	N/A
8151402	12/2011	Takabayashi et al.	N/A	N/A
8161594	12/2011	Policicchio et al.	N/A	N/A
8186001	12/2011	Tsuchiya et al.	N/A	N/A
8225453	12/2011	Yamada	N/A	N/A

8245349	12/2011	Tsuchiya et al.	N/A	N/A
8528151	12/2012	Przepasniak	N/A	N/A
8536074	12/2012	Fereshtekhou et al.	N/A	N/A
8617685	12/2012	Yamada	N/A	N/A
8621704	12/2013	Tsuchiya et al.	N/A	N/A
8646144	12/2013	Wada et al.	N/A	N/A
8752232	12/2013	Otsuka et al.	N/A	N/A
8756746	12/2013	Policicchio	N/A	N/A
8763197	12/2013	Policicchio et al.	N/A	N/A
8793832	12/2013	Yamada	N/A	N/A
8851776	12/2013	Schwarz et al.	N/A	N/A
9113768	12/2014	Wada et al.	N/A	N/A
9198553	12/2014	Policicchio	N/A	N/A
9204775	12/2014	Pung et al.	N/A	N/A
9296176	12/2015	Escaffre et al.	N/A	N/A
9339165	12/2015	Vetter et al.	N/A	N/A
10722091	12/2019	Policicchio	N/A	N/A
10730081	12/2019	Policicchio	N/A	N/A
11045061	12/2020	Policicchio	N/A	N/A
11253128	12/2021	Policicchio et al.	N/A	N/A
11903542	12/2023	Policicchio	N/A	N/A
2002/0065012	12/2001	Takabayashi et al.	N/A	N/A
2002/0148061	12/2001	Tanaka	N/A	N/A
2002/0148062	12/2001	Charbeneau	N/A	N/A
2006/0171764	12/2005	Hoadley	N/A	N/A
2006/0185108	12/2005	Hoadley et al.	N/A	N/A
2007/0077403	12/2006	Litvay	N/A	N/A
2008/0028560	12/2007	Policicchio et al.	N/A	N/A
2008/0235890	12/2007	Tsuchiya et al.	N/A	N/A
2009/0007355	12/2008	Policicchio et al.	N/A	N/A
2010/0015383	12/2009	Yamada	N/A	N/A
2010/0088837	12/2009	Wada et al.	N/A	N/A
2010/0154156	12/2009	Takabayashi et al.	N/A	N/A
2011/0088189	12/2010	Wada	N/A	N/A
2011/0277258	12/2010	Otsuka	N/A	N/A
2012/0297563	12/2011	Tsuchiya et al.	N/A	N/A
2012/0311803	12/2011	Yamada	N/A	N/A
2014/0182767	12/2013	Goto et al.	N/A	N/A
2014/0187406	12/2013	Matsumoto et al.	N/A	N/A
2015/0336366	12/2014	Matsumoto et al.	N/A	N/A
2015/0351602	12/2014	Goto	N/A	N/A
2015/0374196	12/2014	Suda	N/A	N/A
2017/0360271	12/2016	Policicchio	N/A	N/A
2018/0042439	12/2017	Policicchio	N/A	N/A
2019/0075993	12/2018	Policicchio et al.	N/A	N/A
2019/0075994	12/2018	Policicchio	N/A	N/A
2019/0075995	12/2018	Policicchio	N/A	N/A
2019/0076886	12/2018	Policicchio	N/A	N/A
2019/0104909	12/2018	Policicchio	N/A	N/A
2019/0298141	12/2018	Policicchio	N/A	N/A

2019/0298142	12/2018	Policicchio	N/A	N/A
2019/0343365	12/2018	Tsuchiya et al.	N/A	N/A
2022/0273153	12/2021	Policicchio	N/A	N/A

## FOREIGN PATENT DOCUMENTS

Patent No.	Application Date	Country	CPC
0923902	12/1998	EP	N/A
2000316772	12/1999	JP	N/A
2008146821	12/2007	WO	N/A
2009084500	12/2008	WO	N/A

## OTHER PUBLICATIONS

15184 PCT Search Report and Written Opinion for PCT/US2019/023571; dated Jun. 4, 2019, 13 pages. cited by applicant

All Office Actions, U.S. Appl. No. 15/943,739, filed Apr. 3, 2018. cited by applicant

All Office Actions, U.S. Appl. No. 15/943,740, filed Apr. 3, 2018. cited by applicant

All Office Actions, U.S. Appl. No. 15/943,741, filed Apr. 3, 2018. cited by applicant

All Office Actions; U.S. Appl. No. 17/743,918, filed May 13, 2022. cited by applicant

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## Background/Summary

### FIELD OF THE INVENTION

(1) The present invention relates to cleaning articles having tufts of tow fibers for cleaning.

### BACKGROUND OF THE INVENTION

(2) Various cleaning articles have been created for dusting and light cleaning. For example, cloth rags and paper towels used dry or wetted with polishing and cleaning compositions have been used on relatively flat surfaces such as countertops, showers, sinks and floors. Laminiferous wipes have been proposed, as disclosed in U.S. Pat. No. 9,296,176. But, rags, wipes, and paper towels are problematic for reasons such as hygiene (the user's hands may touch chemicals, dirt or the surface during cleaning), reach (it may be difficult to insert the user's hand with the rag, wipe or paper towel into hard-to-reach places) and inconvenience (cleaning between closely-spaced articles typically requires moving the articles).

(3) To overcome the problems associated with using rags and paper towels, various reusable dust gathering devices using felt and hair have been utilized for more than a century, as illustrated by U.S. Pat. No. 823,725 issued in 1906 to Hayden and using yarns as illustrated in U.S. Pat. No. 4,145,787. To address the problems with reusable dust gathering devices, disposable cleaning articles have been developed which have limited re-usability. These disposable cleaning articles may include synthetic fiber tufts, called tow fibers, attached to a sheet as shown in US Application 2006/0171764; U.S. Pat. Nos. 6,143,393; 6,241,835; 6,319,593; 6,329,308; 6,554,937; 6,774,070; 6,813,801; 6,830,801; 6,984,615; 7,003,856; 7,566,671; 7,712,178; 7,779,502; 7,870,635; 7,937,797; 8,146,197; 8,151,402; 8,161,594, 8,186,001; 8,225,453; 8,245,349; 8,646,144; 8,528,151; 8,617,685; 8,646,144; 8,752,232; 8,756,746; 8,763,197; 8,793,832; 9,113,768; 9,198,553 and in commonly assigned U.S. Pat. No. 8,075,977.

(4) Disposable dusters having tow fibers may provide for wet cleaning as disclosed in U.S. Pat. No. 7,566,671 and in commonly assigned U.S. Pat. No. 7,803,726 and commonly assigned US Application 2008/0028560. But tow fibers may become matted when wet and not be suitable for

cleaning a large or heavily wetted surface, such as a floor. Thus, dusters may not be suitable for cleaning extremely large or heavily soiled surfaces.

(5) Thus various sheets have been proposed for cleaning larger target surfaces, such as floors. Webs with elastic behavior have been proposed in commonly assigned U.S. Pat. No. 5,691,035. Sheets with recesses have also been proposed, as disclosed in U.S. Pat. Nos. 6,245,413; and 7,386,907. Sheets with cavities have been proposed, as disclosed in U.S. Pat. No. 6,550,092. An adhesive cleaning sheet is proposed in U.S. Pat. No. 7,291,359. Tufts are taught in commonly assigned U.S. Pat. Nos. 7,682,686, 7,838,099 and/or 8,075,977. Yet other attempts use coatings of wax and/or oil. Coatings, such as wax and oil are generally disclosed in U.S. Pat. Nos. 6,550,092; 6,777,064; 6,797,357; 6,936,330; 6,984,615; 7,386,907; 7,560,398; 7,786,030; 8,536,074; 9,204,775 and 9,339,165. Specific amphiphilic coatings are disclosed in U.S. Pat. No. 8,851,776.

(6) Some of the prior art attempted to focus on debris as simply large and small, based upon the size of the debris intended to be collected. But these teachings do not always address the proper use of tow fibers to collect the range of debris commonly found when cleaning a floor. Prior art attempts to incorporate tow fibers into cleaning sheets did not account for such differences in volume and density. Higher density, granular debris, such as dirt, is not necessarily captured by tow fibers. Tow fibers which are spaced too far apart may not even come in contact with dense, granular debris, much less clean such debris from the surface. And tow fibers which are spaced too closely may not intercept and hold the more voluminous, lower density debris. Even if such debris is initially captured, prior art sheets have not addressed the problem of how to retain such debris by the sheet.

(7) Accordingly, this invention addresses the problem of how to incorporate tow fibers into a hard surface cleaning article for capture and retention of the wide range of debris encountered in everyday cleaning by through the preferential treatment of tow tufts on a cleaning sheet.

## SUMMARY OF THE INVENTION

(8) The invention comprises a cleaning article bounded by edges, having a longitudinal axis and comprising a carrier sheet, and a plurality of discretely spaced tufts of tow fibers joined to the carrier sheet. The tufts have secondary bonds therethrough, creating channels for the accumulation of debris.

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## Description

### BRIEF DESCRIPTION OF THE DRAWINGS

(1) In the figures, the bond lines and the footprint of the cleaning article are drawn to scale. The tufts of tow fibers are shown schematically. As used herein, the top view is the view of the cleaning article which faces towards and contacts the target surface. The bottom view is opposed to the top view and faces towards the head of a cleaning device when the cleaning article is attached thereto.

(2) FIG. 1A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with constant width continuous secondary bonds oriented generally parallel to the transverse axis.

(3) FIG. 1B is a top view of the cleaning article of FIG. 1A having discrete tufts represented with a common proximal end for each tuft.

(4) FIG. 1C is a bottom plan view of the cleaning article of FIGS. 1A and 1B.

(5) FIG. 1D is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with variable width continuous secondary bonds oriented generally parallel to the transverse axis.

(6) FIG. 1E is a top view of the cleaning article of FIG. 1D having discrete tufts represented with a common proximal end for each tuft.

(7) FIG. 1F is a bottom plan view of the cleaning article of FIGS. 1D and 1E.

- (8) FIG. 2A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with interrupted constant width secondary bonds oriented generally parallel to the transverse axis.
- (9) FIG. 2B is a top view of the cleaning article of FIG. 2A having discrete tufts represented with a common proximal end for each tuft.
- (10) FIG. 2C is a bottom plan view of the cleaning article of FIGS. 2A and 2B.
- (11) FIG. 2D is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with interrupted variable width secondary bonds oriented generally parallel to the transverse axis.
- (12) FIG. 2E is a top view of the cleaning article of FIG. 2D having discrete tufts represented with a common proximal end for each tuft.
- (13) FIG. 2F is a bottom plan view of the cleaning article of FIGS. 2D and 2E.
- (14) FIG. 3A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with continuous paired secondary bonds oriented generally parallel to the transverse axis.
- (15) FIG. 3B is a top view of the cleaning article of FIG. 3A having discrete tufts represented with a common proximal end for each tuft.
- (16) FIG. 3C is a bottom plan view of the cleaning article of FIGS. 3A and 3B.
- (17) FIG. 4A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired, interrupted secondary bonds oriented generally parallel to the transverse axis.
- (18) FIG. 4B is a top view of the cleaning article of FIG. 4A having discrete tufts represented with a common proximal end for each tuft.
- (19) FIG. 4C is a bottom plan view of the cleaning article of FIGS. 4A and 4B.
- (20) FIG. 5A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with continuous secondary bonds oriented diagonal to the transverse axis.
- (21) FIG. 5B is a top view of the cleaning article of FIG. 5A having discrete tufts represented with a common proximal end for each tuft.
- (22) FIG. 5C is a bottom plan view of the cleaning article of FIGS. 5A and 5B.
- (23) FIG. 6A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with offset interrupted secondary bonds oriented diagonal to the longitudinal axis.
- (24) FIG. 6B is a top view of the cleaning article of FIG. 6A having discrete tufts represented with a common proximal end for each tuft.
- (25) FIG. 6C is a bottom plan view of the cleaning article of FIGS. 6A and 6B.
- (26) FIG. 7A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired continuous secondary bonds oriented diagonal to the transverse axis.
- (27) FIG. 7B is a top view of the cleaning article of FIG. 7A having discrete tufts represented with a common proximal end for each tuft.
- (28) FIG. 7C is a bottom plan view of the cleaning article of FIGS. 7A and 7B.
- (29) FIG. 8A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with offset paired interrupted secondary bonds oriented diagonal to the transverse axis.
- (30) FIG. 8B is a top view of the cleaning article of FIG. 8A having discrete tufts represented with a common proximal end for each tuft.
- (31) FIG. 8C is a bottom plan view of the cleaning article of FIGS. 8A and 8B.
- (32) FIG. 9A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with continuous chevron secondary bonds oriented in the

longitudinal direction.

(33) FIG. 9B is a top view of the cleaning article of FIG. 9A having discrete tufts represented with a common proximal end for each tuft.

(34) FIG. 9C is a bottom plan view of the cleaning article of FIGS. 9A and 9B.

(35) FIG. 10A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with interrupted chevron secondary bonds, forming herring bones oriented in the longitudinal direction.

(36) FIG. 10B is a top view of the cleaning article of FIG. 10A having discrete tufts represented with a common proximal end for each tuft.

(37) FIG. 10C is a bottom plan view of the cleaning article of FIGS. 10A and 10B.

(38) FIG. 11A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired continuous chevron secondary bonds oriented in the longitudinal direction.

(39) FIG. 11B is a top view of the cleaning article of FIG. 11A having discrete tufts represented with a common proximal end for each tuft.

(40) FIG. 11C is a bottom plan view of the cleaning article of FIGS. 11A and 11B.

(41) FIG. 12A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired, interrupted, constant width chevron secondary bonds, forming herring bones oriented in the longitudinal direction.

(42) FIG. 12B is a top view of the cleaning article of FIG. 12A having discrete tufts represented with a common proximal end for each tuft.

(43) FIG. 12C is a bottom plan view of the cleaning article of FIGS. 12A and 12B.

(44) FIG. 12D is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired, interrupted variable width chevron secondary bonds, forming herring bones oriented in the longitudinal direction with offset zones for collection of debris.

(45) FIG. 12E is a top view of the cleaning article of FIG. 12D having discrete tufts represented with a common proximal end for each tuft.

(46) FIG. 12F is a bottom plan view of the cleaning article of FIGS. 12D and 12E.

(47) FIG. 13A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with continuous secondary bonds forming diamond patterns.

(48) FIG. 13B is a top view of the cleaning article of FIG. 13A having discrete tufts represented with a common proximal end for each tuft.

(49) FIG. 13C is a bottom plan view of the cleaning article of FIGS. 13A and 13B.

(50) FIG. 14A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with interrupted secondary bonds forming diamond patterns.

(51) FIG. 14B is a top view of the cleaning article of FIG. 14A having discrete tufts represented with a common proximal end for each tuft.

(52) FIG. 14C is a bottom plan view of the cleaning article of FIGS. 14A and 14B.

(53) FIG. 15A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired continuous secondary bonds forming diamond patterns.

(54) FIG. 15B is a top view of the cleaning article of FIG. 15A having discrete tufts represented with a common proximal end for each tuft.

(55) FIG. 15C is a bottom plan view of the cleaning article of FIGS. 15A and 15B.

(56) FIG. 16A is a top view of a cleaning article according to the present invention and having discrete tufts represented as diamonds, with paired interrupted secondary bonds forming diamond patterns.

(57) FIG. **16B** is a top view of the cleaning article of FIG. **16A** having discrete tufts represented with a common proximal end for each tuft.

(58) FIG. **16C** is a bottom plan view of the cleaning article of FIGS. **16A** and **16B**.

(59) FIG. **17** is a schematic top plan view of a cleaning article according to the present invention and various combinations of the aforementioned secondary bonds, having the tufts omitted for clarity.

(60) FIG. **18** is a bar graph showing the performance of cleaning articles according to the present invention.

(61) FIG. **19A** is a top view of a cleaning article according to the prior art and having discrete tufts disposed in a uniform grid and represented with a common proximal end for each tuft. FIG. **19A** schematically shows accumulation of large and medium sized debris at the leading edge of the tufts.

(62) FIG. **19B** is a side elevational view of the cleaning article of FIG. **19A**, showing constant thickness of the tufts in the z direction.

(63) FIG. **20A** is a perspective view of a floor cleaning implement suitable for use with the claimed invention and having a cleaning article attachable thereto.

(64) FIG. **20B** is a perspective view of a floor cleaning implement suitable for use with the present invention and which sprays liquid cleanser on the floor.

(65) FIG. **20C** is a perspective view of a handle suitable for use with a duster type cleaning article according to the claimed invention.

#### DETAILED DESCRIPTION OF THE INVENTION

(66) Referring generally to FIGS. **1A-17**, the cleaning article **10** may be generally elongate, and rectangular, although other shapes are contemplated and feasible. The cleaning article **10** may comprise two or more components joined in a laminate form to provide cleaning article **10** suitable for floor cleaning. The cleaning article **10** may have a carrier sheet, which forms a chassis for attachment of other components thereto. The cleaning article **10** has a plurality of tufts **15** made of tow fibers. The tufts **15** may be disposed in rows **30** forming a grid or field of tufts **15**. The tufts **15** are joined to the carrier sheet by a first plurality of primary bonds **32**. A second plurality of secondary bonds **34** forms channels or groves through the tufts **15**, to provide for accumulation of debris therein.

(67) The cleaning article **10** may be disposable. By disposable it is meant that the cleaning article **10** may be used for one cleaning task, or generally for not more than several square meters, then discarded. In contrast, a reusable cleaning article **10** is laundered or otherwise restored after use.

(68) As used herein, the cleaning article **10** according to the present invention, and particularly the carrier sheet thereof is macroscopically planar and defines an XY plane. The tufts **15** extend outwardly in the Z direction perpendicular to the XY plane. The cleaning article **10** may have a longitudinal axis LA defining a longitudinal direction and a transverse axis TA orthogonal thereto and defining a transverse direction, both axes LA, TA lying within the XY plane. The cleaning article **10**, and respective components thereof, may have two longitudinal edges **20** parallel to the longitudinal axis LA and two transverse edges **22** parallel to the transverse axis TA. For example, the field of tufts **15** may define a longitudinal edge **220** and transverse edge **222** disposed within the carrier sheet.

(69) The length of the cleaning article **10** is taken in the longitudinal direction. The width of the cleaning article **10** corresponds to the transverse direction perpendicular to the length direction and disposed within the plane of the sheet. The XY plane is defined as the plane defined by the cleaning article **10**. The Z-direction of the cleaning article **10** is the direction perpendicular to the plane of the cleaning article **10**. The thickness is defined as the dimension in the Z direction. The cleaning article **10** may have a length from 20 to 50 cm and a width of 10 to 30 cm. The cleaning article **10** may particularly be 30+/-2 cm long by 14+/-2 cm wide, as measured at the greatest dimensions, in order to fit the head **74** of a typical cleaning implement **70**, as discussed below. Of course, one of



skill will recognize that other shapes are feasible and within the scope of the present invention.

(70) The cleaning article **10** may have an outwardly facing cleaning side and an attachment side opposed thereto. The cleaning article **10** is intended to be used dry, although wet cleaning is contemplated and within the scope of the present invention. The cleaning article **10** may also have an optional absorbent core for wet cleaning. An optional core may particularly have a width of 6.5+/-2 cm and a length of 26+/-2 cm.

(71) More particularly, the cleaning article **10** may comprise a construction of at least one tow fiber tuft **15** and at least one carrier sheet. The tow fiber tuft **15** and carrier are joined in face-to-face relationship with at least one permanent primary bond **32** to form a laminate. The tow fiber tuft(s) **15** may be distended from and extend outwardly from the plane of the carrier sheet to provide a thickness in the z-direction. The tufts **15** may be disposed directly on a carrier sheet. Optionally, the tufts **15** may be bonded to a precursor sheet, which, in turn, is joined to a carrier sheet.

(72) The carrier sheet may particularly comprise a synthetic nonwoven. A carrier sheet having synthetic fibers provides for convenient joining of the tow fibers thereto. Nonwovens include spun bonded, carded and airlaid materials, as are known in the art and made from synthetic fibers. A suitable nonwoven sheet may be made according to commonly assigned U.S. Pat. No. 6,797,357. The carrier sheet may optionally comprise a polyolefinic film, or a microfiber and be liquid pervious or impervious.

(73) The carrier sheet may comprise cellulose, to provide absorptive capacity. A cellulosic sheet may have permanent wet strength resin added thereto, as is known in the art. Or the carrier sheet may preferably comprise a mixture of cellulosic and synthetic fibers, to provide both absorptive and barrier properties.

(74) The carrier sheet may comprise a hydroentangled spunbond nonwoven with a basis weight of 20 to 80 gsm. A 45 gsm nonwoven from Avgol Nonwovens of Tel-Aviv, Israel has been found suitable. The carrier sheet may comprise a laminate of two, three or more plies joined together using adhesive and/or thermal bonds as are known in the art. Optional attachment stripes of loop or similar material may be joined to the attachment side to removably join the cleaning article **10** to a handle **72** or implement **70**. One or more plies of the carrier sheet may comprise a microfiber, particularly a nylon microfiber, as is known in the art.

(75) The cleaning article **10** may have an optional cleaning strip element. The cleaning strip element may comprise a polyolefinic film, having integral protrusions as disclosed in commonly assigned U.S. Pat. No. 8,407,848 or may be a rope of tow fibers. The cleaning strip element may preferably comprise a mixture of wet laid fibers formed into a tissue which is bonded onto a synthetic nonwoven using a process such as spun lace or hydroentangling. The cleaning element may particularly comprise a 23 gsm tissue with a 17 gsm polypropylene spunbond as a composite, sold under the name Genesis tissue by Suominen of Helsinki, Finland. Or, the cleaning strip element, precursor sheet and/or the carrier sheet may alternatively or additionally comprise nylon microfiber.

(76) The tow fibers, and tufts **15** formed therewith, may be synthetic, comprising polymers including polyester, polypropylene, polyethylene, bio-derived polymers such as polylactic acid, bio-polyethylene, bio-polyester and the like. Tow fibers may also include fibers from natural sources such as cellulose, cellulose acetate, flax, hemp, jute and mixtures thereof manufactured wherein the individual fibers are relatively long strands manufactured in bundles. Preferred tow fibers are bicomponent fibers having a PP or PE core with a polyethylene sheath. The tow fibers may have a denier per filament of 1.5 to 8.0 and a total crimped denier of 15,000 to 95,000. Tow fibers are a component in Swiffer® Dusters™ sold by the instant assignee.

(77) The tow fiber tuft(s) **15** may be joined to the carrier sheet by a plurality of permanent primary bonds **32**. The primary bonds **32** are intended to minimize or prevent stray or dislodged tow fibers from becoming loose from the carrier sheet. Such sheets **12** and tow fiber tuft(s) **15** may typically be directly superimposed on one another, with or without intervening sheets, members or

components therebetween. The primary bonds **32** may be ultrasonic bonds, adhesive bonds, thermal bonds or a combination thereof, as are known in the art.

(78) The cleaning article **10** also has a secondary plurality of secondary bonds **34**. The secondary bonds **34** are formed after the tufts **15** are joined to the carrier sheet by the primary bonds **32**. The secondary bonds **34** are generally linear, having an aspect ratio within the XY plane of at least 1, preferably at least 10 and more preferably at least 20. The secondary bonds **34** reduce the thickness of the tufts **15** in the Z direction. The reduced thickness of the secondary bonds **34**, relative to the balance of the tufts **15** aligned with the edges of the secondary bonds **34**, creates channels to intercept debris. The secondary bonds **34** may be of constant width, or may converge towards a distal end thereof.

(79) The secondary bonds **34** may be of uniform size, orientation relative to the longitudinal axis, and spacing. Alternatively, the secondary bonds **34** may be of variable width, length, spacing, angular orientation and/or geometry, as desired.

(80) The channels formed by the secondary bonds **34** allow large debris to enter in a direction approaching the longitudinal axis LA of the cleaning article **10**. Particularly, this arrangement provides the benefit during ordinary use that larger debris can be intercepted in the channel formed by the secondary bond, while smaller debris is intercepted by the tufts **15**.

(81) The secondary bonds **34** may have adhesive disposed thereon. The adhesive assists in retention of debris which enters the channels formed by the secondary bonds **34**. Suitable adhesive includes contact adhesive. The adhesive may be applied to the secondary bonds **34** by spraying, rollers and other techniques known in the art for zone coating.

(82) The transverse edge **222** of the field of tufts **15** may be juxtaposed with or coincident the transverse edge **22** of the carrier sheet. Preferably a perimeter bond **34P** joins the tow fibers of the field of tufts **15** at the respective transverse edges, **22**, **222**. This arrangement prevents loss of tow fibers from occurring when separating an individual cleaning article **10** from a continuous web or upon a slit **36** being near a transverse edge **22** without an intervening primary bond **32**. As used herein, a slit **36** is a cut through the two fibers and underlying carrier sheet, thereby forming a tuft **15**.

(83) The cleaning article **10** according to the present invention may be made by providing a carrier sheet. Tow fibers are disposed on the carrier sheet. For the embodiments shown herein, the tow fibers are generally aligned in the longitudinal direction, although the invention is not so limited. The tow fibers are joined to the carrier sheet with transversely offset primary bonds **32**. The primary bonds **32** are oriented in the transverse direction. The primary bonds **32** are shown as teardrops, although the invention is not so limited. The primary bonds **32** may be linear or of any desired shape and size, so long as the tow fibers are permanently joined to the carrier sheet thereby.

(84) Tufts **15** are created by cutting the carrier sheet and tow fibers between the primary bonds **32** with a plurality of slits. The proximal ends of the tow fibers forming a tuft **15** are defined by a respective primary bond **32**. Two continuous slits **36** define and form the proximal ends of the tow fibers of a respective tuft **15**.

(85) The tufts **15** may be optionally fluffed to increase the thickness of the tufts **15** in the Z direction. Optional fluffing may be accomplished by blowing air, as is known in the art.

(86) After the slits **36** are formed and fluffing, if any, occurs, the secondary bonds **34** are applied. The secondary bonds **34** may be formed in the same manner as the primary bonds **32**, or may be formed by different methods. The secondary bonds **34** may be ultrasonic bonds, adhesive bonds, thermal bonds or a combination thereof, as are known in the art. Any such method of forming the secondary bonds **34** is suitable, so long as visually discernable secondary bonds **34** are formed and provide a thickness difference in the Z direction between the secondary bond **34** and at least two or more adjacent tufts **15** of tow fibers.

(87) The secondary bonds **34** preferably intercept the longitudinal edge **220** of the field of tufts **15**. This arrangement allows an opening for large debris to enter the field of tufts **15** in a direction

towards the longitudinal axis and be retained by adhesive and/or tufts **15** adjacent to and which form the border of the secondary bond. Without the secondary bonds **34**, large debris may become entrapped on the longitudinal edge **220** of the field of tufts **15** and occlude the tufts **15** from intercepting additional debris.

(88) This geometry provides the benefit that when used with a common sized cleaning implement **70**, such as the Swiffer® Sweeper™ implement **70** sold by the instant assignee, tufts **15** and secondary bonds **34** may wrap the nose of the head **74** of the cleaning implement. Wrapping the nose of the head **74** of the cleaning implement **70** is believed to improve cleaning along walls and baseboards.

(89) The amount of tufts **15** on the nose can be controlled by and is inversely proportional to the width of the secondary bonds **34**.

(90) Referring particularly to FIGS. **1A-4C**, the cleaning article **10** may have continuous secondary bonds **34** which are parallel to the transverse axis TA. This geometry provides the benefit that the secondary bond **34** channels can allow debris to enter generally in the direction of forward and backward motion while, providing sufficient volume to accommodate large amounts of debris.

(91) The secondary bond **34** alignment being parallel to the transverse direction is generally oriented in the cross-machine direction and perpendicular to the machine direction. Thermal bonding and ultrasonic bonding typically occur in the cross-machine direction at any point in time. As the size of the secondary bond **34** increases in the cross-machine direction, the amount of amperage necessary to form the secondary bond **34** likewise increases. Increased amperage typically results in increased equipment cost and resulting increased manufacturing cost. Certain variant embodiments described below are stated to have the advantage of reduced amperage necessary to form the secondary bond **34** relative to the amperage required to form a comparable secondary bond **34** parallel to the transverse direction using thermal bonding and/or ultrasonic bonding.

(92) While generally parallel and equally spaced rows of tufts **15** are shown, the invention is not so limited. Prophetically from two to 15 rows could be used, with equal or unequal spacing and equal or unequal variable widths and equal or unequal tuft **15** density. The rows of tufts **15** may be mutually parallel to the transverse axis, mutually skewed thereto or be mutually skewed relative to other rows. Optionally, adhesive may be disposed in the spaces between the rows **30**. The rows **30** may both extend throughout the transverse direction and be interrupted at the longitudinal axis. The tapered intra-tuft spaces between the tufts **15** provide the benefit that no tufts **15** are interrupted by the spaces. Thus all tufts **15** can be selected to be of a size large enough for efficacious cleaning.

(93) The pitch, and thus tuft **15** density, may be constant at any predetermined spacing from the longitudinal edge **20**. The tufts **15** may be bilaterally staggered relative to the longitudinal axis and transverse axis. The tufts **15** may fully overlap the position of adjacent tufts **15**, in both directions, to provide adequate spacing therebetween and debris retention during back and for the sweeping. Alternatively, each tuft **15** having a maximum diameter, or other maximum dimension taken parallel to the longitudinal axis, and the pitch between adjacent tufts **15** in a particular row may be greater than that maximum diameter/dimension.

(94) The cleaning article according may be tri-folded generally parallel to said longitudinal axis, as is common in the art. This arrangement provides two outboard trisections, commonly used for attachment to the head **74** of a cleaning implement. If desired, tufts **15** may be disposed in at least one of, and optionally both of, the outboard trisections, to provide for cleaning along walls and baseboards.

(95) This geometry provides the benefit that when used with a common sized cleaning implement **70**, such as the Swiffer® Sweeper™ implement **70** sold by the instant assignee, tufts **15** may wrap the nose of the head **74** of the cleaning implement. Wrapping the nose of the head **74** of the cleaning implement **70** is believed to improve cleaning along walls and baseboards. The amount of tufts **15** on the nose can be controlled by and is inversely proportional to the width of the spaces **31**.

(96) The cleaning article may optionally be completely or partially coated with adhesive, wax, Newtonian oils and/or non-Newtonian oils or a combination thereof, in order to improve cleaning and increase retention of absorbed debris. Particularly, the tow fiber tuft **15**, in any configuration, may be coated with a mineral oil coating. The coating may comprise a mixture of mineral oil and surfactant at a ratio of about 90% to 10% oil to surfactant. The surfactant provides the benefit inducing the oil to wet the tow fibers by reducing the surface energy. The surfactant may be a non-ionic surfactant.

(97) Referring particularly to FIGS. **1A-1C**, the secondary bonds **34** may have a length **C1** of 11 to 20 cm, a width **C2** of 0.1 to 1.5 cm and a pitch **C3** therebetween of 1 to 10 cm. These secondary bonds **34** intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris. While six equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(98) Referring to FIGS. **1D-1F**, the secondary bonds **34** may be of variable width, to increase surface of the channels formed by the bonds to increase debris retention. The secondary bonds **34** may be monotonically tapered, or bulbous as shown.

(99) Referring particularly to FIGS. **2A-2C**, the cleaning article **10** may have interrupted secondary bonds **34** which are parallel to the transverse axis **TA**. The secondary bonds **34** may have a length **C1** of 2 to 8 cm, and a width **C2** of 0.1 to 1.5 cm. The secondary bonds **34** may have a pitch **C3** therebetween of 1 to 10 cm. The transverse spacing **S3** between secondary bonds **34** may range from 1 to 6 cm. These secondary bonds **34** intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(100) This geometry provides the benefit that the secondary bond **34** channels can allow debris to enter generally in the direction of forward and backward motion while having tufts **15** on and proximate to the longitudinal axis **LA** for retention of large debris.

(101) While 12 equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(102) Referring to FIGS. **2D-2F**, the secondary bonds **34** may be monotonically tapered. This arrangement provides the benefit that as debris enters the channel created by the secondary bond, the debris will become entrapped when the secondary bonds **34** is narrow enough to intercept the debris.

(103) Referring particularly to FIGS. **3A-3C**, the cleaning article **10** may have continuous paired secondary bonds **34** which are parallel to the transverse axis **TA**. By paired secondary bonds **34** it is meant two describe two secondary bonds **34** relatively closely and proximately spaced and which pair is spaced apart from another pair of secondary bonds **34**.

(104) Paired secondary bonds **34**, for each of the embodiments described herein having paired secondary bonds **34**, provides the benefit that a channel can be formed for collection of debris without requiring a relatively wide width for the secondary bond. The secondary bonds **34** are typically formed in the cross-machine direction. As width of the secondary bond **34** increases (in the horizontal direction of FIGS. **3A-3B**), the required amperage to accomplish bonding using heat sealing or ultrasonic bonding likewise increases. Using two, narrower, paired secondary bonds **34** requires less amperage spike than a single, wider secondary bond.

(105) Referring particularly to FIGS. **3A-3C**, each of the paired secondary bonds **34** may have a length **C1** of 11 to 20 cm, and a width **C2** of 0.1 to 1.5 cm. The secondary bond **34** pairs may have a spacing **C3** therebetween of 1 to 10 cm. The channel between paired secondary bonds **34** may range from 0.1 to 1 cm. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(106) This geometry provides the benefit that the secondary bond **34** channels can allow debris to enter generally in the direction of forward and backward motion while having tufts **15** on and proximate to the longitudinal axis **LA** for retention of large debris.

(107) While six pairs of equally spaced secondary bonds **34** are shown, the invention is not so

limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized. The secondary bonds **34** may have differing thickness within a secondary bond **34** pair, or differing thickness between bond pairs as shown.

(108) Referring to FIGS. **4A-4C**, the paired continuous secondary bonds **34** may be interrupted proximate the longitudinal axis **LA**. This geometry provides the benefit that the paired secondary bond **34** channels can allow debris to enter generally in the direction of forward and backward motion while having tufts **15** on and proximate to the longitudinal axis **LA** for retention of large debris.

(109) The interruption between transversely opposed pairs of secondary bonds **34** further provides for reduced amperage during heat sealing or ultrasonic bonding. The reduced amperage potentially reduces manufacturing cost.

(110) Each of the paired secondary bonds **34** may have a length **C1** of 2 to 8 cm, and a width **C2** of 0.05 to 0.5 cm. The secondary bond **34** pairs may have a spacing **C3** therebetween of 1 to 10 cm. The channel **C4** between paired secondary bonds **34** may range from 0.1 to 1 cm. The secondary bonds **34** may have a spacing **S3** across the longitudinal axis **LA** in the transverse direction of 1 to 6 cm. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(111) While 12 pairs of equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer pairs of secondary bonds **34** of similar or different size and/or spacing may be utilized.

(112) Referring to FIGS. **5A-8C**, and **15A-16C**, the secondary bonds **34** may be continuous and diagonally oriented relative to the longitudinal axis **LA**. The diagonal orientation, for all such embodiments described and claimed herein, provides the benefit that during back and forth motion debris entering the channels formed by the secondary bonds **34** can intercept a tuft **15** bordering the channel and be retained thereby. Further, the channels can intercept debris during turns and lateral motions which occur during cleaning.

(113) Furthermore, for all diagonal secondary bond **34** embodiments described and claimed herein, the instantaneous amperage draw of the bonding step during manufacture, is reduced compared to a secondary bond **34** oriented in the transverse direction during ultrasonic bonding or thermal bonding. The reduction in amperage occurs due to less bond area being present at any point in time.

(114) Referring to FIGS. **5A-5C**, each of the secondary bonds **34** may have a length **C1** of 11 to 20 cm, and a width **C2** of 0.1 to 1 cm. The secondary bonds **34** may have a spacing **C3** therebetween of 1 to 10 cm. The secondary bonds **34** may form an angle **A1** with the longitudinal axis **LA** of 30 to 75 degrees. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(115) While seven equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(116) Referring to FIGS. **6A-6C**, the diagonally oriented secondary bonds **34** may be interrupted proximate the longitudinal axis **LA**. Again, this embodiment provides the benefit of tufts **15** on the longitudinal axis for retention of debris and diagonal bonds to reduce the instantaneous amperage required during manufacture. The secondary bonds **34** may be offset from other secondary bonds **34** in the diagonal direction. This arrangement provides the benefit that placement of the secondary bonds **34** may be customized to the intended cleaning task. As shown in FIGS. **6A-6B**, the secondary bonds **34** may be equally or unequally spaced from adjacent secondary bonds **34**.

(117) Each of the secondary bonds **34** may have a length **C1** of 2 to 8 cm, and a width **C2** of 0.1 to 1 cm. The secondary bonds **34** may have a spacing **C3** therebetween of 1 to 10 cm. The secondary bonds **34** may form an angle **A1** with the longitudinal axis of 30 to 75 degrees. The secondary bonds **34** may have a spacing **S3** across the longitudinal axis **LA** in the transverse direction of 1 to 6 cm. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(118) While 14 generally equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(119) Referring to FIGS. 7A-7C, the continuous diagonal secondary bond **34** lines may be paired. This arrangement provides the benefit of reduced instantaneous amperage requirements at any point in time due to the advantageous combination of paired secondary bonds **34** and diagonal orientation.

(120) Each of the secondary bonds **34** may have a length C1 of 11 to 20 cm, and a width C2 of 0.05 to 0.5 cm. The secondary bond **34** pairs may have a spacing C3 therebetween of 1 to 10 cm. The secondary bonds **34** may have a spacing from a paired secondary bond **34** of 0.1 to 1 cm. The secondary bonds **34** may form an angle A1 with the longitudinal axis of 30 to 75 degrees. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(121) While 7 pairs of equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer pairs of secondary bonds **34** of similar or different size and/or spacing may be utilized.

(122) Referring to FIGS. 8A-8C, the secondary bonds **34** may be paired, diagonally oriented, interrupted and offset from the secondary bonds **34** disposed on the other side of the longitudinal axis LA. This arrangement advantageously further reduces the instantaneous amperage required for ultrasonically bonding or thermally bonding the secondary bonds **34**. Again, the tufts **15** proximate the longitudinal axis LA are retained, advantageously increasing capacity for debris.

(123) Each of the secondary bonds **34** may have a length C1 of 2 to 8 cm, and a width C2 of 0.5 to 5 cm. The secondary bond **34** pairs may have a spacing C3 therebetween of 1 to 10 cm and a spacing C4 between paired secondary bonds **34** of 0.1 to 1 cm. The secondary bonds **34** may form an angle A1 with the longitudinal axis of 30 to 75 degrees. The secondary bonds **34** may have a spacing S3 across the longitudinal axis LA in the transverse direction of 1 to 6 cm. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(124) While 14 pairs of generally equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(125) Referring to FIGS. 9A-12C, 19A-19C and 22A-22C, the secondary bonds **34** may be continuous chevrons, bridging across the longitudinal axis LA. Chevrons provide the benefit of reduced instantaneous amperage requirements for thermal bonding and ultrasonic bonding of the secondary bonds **34**. The diagonal legs of the chevron each provide for retention of debris in the channels of the secondary bonds **34**. The chevrons advantageously provide for diagonally oriented channels in two different directions. The two different orientations provide the benefit of intercepting dirt in different directions as the cleaning motion occurs in various directions.

(126) FIGS. 9A-9C also show the absence of optional perimeter bonds **34P**. Eliminating the perimeter bonds **34P** provides the benefit of reduced amperage necessary to form the perimeter bonds **34P**, particularly if the perimeter bonds **34P** are parallel to the transverse direction. Of course, tow fibers may become dislodged without the perimeter bonds **34P**.

(127) Each leg of the secondary bonds **34** may have a length C1 of 5 to 10 cm, and a width C2 of 0.1 to 1 cm. The secondary bond **34** may have a spacing C3 therebetween of 1 to 10 cm. The secondary bonds **34** may form an angle A1 with the longitudinal axis of 30 to 75 degrees. These secondary bonds **34** may intercept both longitudinal edges **220** of the field of tufts **15** to allow convenient entry of debris.

(128) While six equally spaced secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(129) Referring to FIGS. 10A-10C, the secondary bonds **34** may form an interrupted chevron

pattern, forming a herring bone pattern oriented in the longitudinal direction. The herring bone pattern provides the benefit of reduced instantaneous amperage requirements for thermal bonding and ultrasonic bonding of the secondary bonds **34**. The diagonal legs of each herring bone provide for retention of debris in the channels of the secondary bonds **34**. The herring bone pattern advantageously provides for diagonally oriented channels in two different directions. The two different orientations provide the benefit of intercepting dirt in different directions as the cleaning motion occurs in various directions. The tufts **15** proximate the longitudinal axis LA provide the benefit of increased capacity for debris retention and further reduces the amperage required to form the secondary bonds **34**.

(130) While six secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(131) Referring to FIGS. **11A-11C**, the secondary bonds **34** may be in the form of paired continuous chevrons. This arrangement provides the benefit of retention at the vertices and more secondary bonds **34** to intercept debris. The secondary bonds **34** may have a transverse span S2 of 10 to 18 cm, each leg of the chevron secondary bond **34** having a length C1 of 5 to 10 cm, a secondary bond **34** width C2 of 0.1 to 1 cm, a spacing C3 between pairs of secondary bonds **34** of 0.1 to 10 cm and a spacing C4 between secondary bonds **34** within a pair of 0.1 to 1 cm. The secondary bonds **34** may be formed on an angle A1 relative to the longitudinal axis LA of 30 to 75 degrees.

(132) While six equally spaced secondary bond **34** pairs are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(133) Referring to FIGS. **12A-12C**, the interrupted chevron-shaped secondary bonds **34** may be paired, to provide more channels to intercept debris. The secondary bonds **34** may be spaced apart a distance S3 across the longitudinal axis LA of 1 to 6 cm.

(134) While 14 generally equally spaced secondary bond **34** pairs are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(135) Referring to FIGS. **12D-12F**, any of the aforementioned embodiments may have secondary bonds **34** of variable width. This arrangement provides the benefit of more surface area within the channel formed by a secondary bond. Prophetically, the increased surface area is believed to provide more entrapment of debris within the channel. Likewise the enlarged and relatively wider portion of the secondary bond **34** is believed to increase the reservoir available for accumulation of debris. The enlarged portions of the secondary bonds **34** may be offset in the longitudinal direction provide for accumulation as the user moves the cleaning article in various directions.

(136) Referring to FIGS. **13A-16C**, the may be diamond shaped. Of course it is to be recognized that similar shapes, having curvilinear sides and no vertices may be used for the secondary bonds **34**. The diamond shaped secondary bonds **34** again provide the benefit of reduced amperage draw during the bonding step of the manufacturing process, due to less bond area being presented at any point in time. The diamond shapes provide the benefit for the secondary bonds **34** of channels which are oriented in opposed directions relative to the longitudinal axis LA, providing more opportunity to entrap debris. The is a symmetrical secondary bond **34** pattern for capturing debris during back and forth cleaning motion.

(137) Referring to FIGS. **13A-13C**, the secondary bonds **34** may be solid and continuous from essentially one longitudinal edge of the tuft field **220** to the other. This arrangement provides the benefit of greater secondary bond **34** length. The dimensions of the secondary bonds **34** cited above are believed suitable for this embodiment, with a spacing C3 between vertices of adjacent bonds of 2 to 20 cm and a length C1 of the secondary bond **34** of 11 to 20 cm.

(138) While five full and partial equally spaced diamond shaped secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(139) Referring to FIGS. **14A-14C**, the diamond shaped secondary bonds **34** may be interrupted proximate the centerline. This arrangement provides the benefit of tufts **15** proximate the longitudinal axis LA for capacity, while retaining the aforementioned symmetry. The secondary bonds **34** may be spaced apart a distance in the transverse direction S3 of 1 to 6 cm. The open end of a secondary bond **34** may be spaced from an adjacent open end a longitudinal distance A3A 2 to 10 cm.

(140) While 10 equally spaced diamond shaped secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(141) Referring to FIGS. **15A-15C**, the continuous diamond shaped secondary bonds **34** may be paired, to provide more channels to intercept debris. Again, the aforementioned symmetry is retained.

(142) While five full and partial equally spaced diamond shaped secondary bonds **34** are shown, the invention is not so limited. More or fewer secondary bonds **34** of similar or different size and/or spacing may be utilized.

(143) Referring to FIGS. **16A-16C**, the paired secondary bonds **34** may be interrupted, to provide more tuft capacity proximate the longitudinal axis LA. The aforementioned dimensions for the preceding diamond shaped secondary bond **34** embodiments are believed to be suitable.

(144) While 10 full and partial equally spaced diamond shaped secondary bond **34** pairs are shown, the invention is not so limited. More or fewer of similar or different size and/or spacing may be utilized.

(145) Referring to FIGS. **3A-4C**, **7A-8C**, **11A-12F**, **15A-16C** and **17**, pairs of secondary bonds **34** may be utilized as shown. But the invention is not so limited. Three, four or more secondary bonds **34** may be closely spaced and disposed away from other closely spaced secondary bonds **34**. Paired secondary bonds **34**, or closely spaced secondary bonds **34** in general, provide the benefit that the thickness of the tufts **15** therebetween is greater than the thickness directly subjacent the secondary bond, and less than the thickness of a tuft **15** which is not bonded. This arrangement provides the benefit that regions of three different thicknesses in the z-direction of the cleaning article **10** are formed.

(146) Referring to FIG. **17**, the secondary bonds **34** may be equally or unequally spaced from adjacent secondary bonds **34**. The secondary bonds **34** may be of like geometry, size, angular orientation and shape or may be of mutually different geometry, size, angular orientation and/or shape. The cleaning article **10** may optionally have strips **17**. The strips **17** have an aspect ratio of length to width greater than 1. Optionally, an elongate tow fiber rope oriented generally parallel to and optionally coincident the longitudinal axis LA may be used.

(147) Referring to FIG. **18**, uniform grid, tufted cleaning articles according to the prior art having a low level of coating and high level of coating was tested for pickup, as shown by control Samples **1A** and **2A**, respectively.

(148) Referring to FIGS. **19A-19B**, the control cleaning articles were made according to U.S. Pat. No. 8,617,685 and had a uniform grid of tufts **15**.

(149) These cleaning articles according to the prior art picked up about 1.88 grams and 2.02 grams of debris respectively.

(150) Two cleaning articles **10** according to the present invention having the same coating levels were also tested, as shown by Samples **1B** and **2B**, respectively.

(151) The cleaning articles had the bond pattern shown in FIGS. **5A-5C**. These cleaning articles **10** secondary bonds **34** which were 4 mm wide on a 30 mm pitch. These cleaning articles **10** according to the present invention unexpectedly picked up about 1.96 grams and 2.13 grams of debris, respectively.

(152) As shown in Table 1 below, the unpredicted improvement in pickup is shown in Table 1 below.



(153) TABLE-US-00001 TABLE 1 Percentage Pickup in Improvement Sample Grams over Control  
1A 1.88 Control 1B 2.02 7.4 2A 1.96 Control 2B 2.13 8.7

(154) As shown in Table 1, the improvement in pickup is 7.4% for the low coating cleaning article **10** and 8.7% for the high coating cleaning article **10**. The average improvement in performance as measured by pickup is 8.05%. An 8% performance improvement is considered significant, as the control cleaning articles according to the prior art are considered to be very efficacious.

(155) Referring to FIG. **20A**, the cleaning article **10** may be removably attachable to a cleaning implement **70** for use with dry, wet and/or prewetted cleaning, depending upon the particular task. The cleaning implement **70** may have a head **74** for receiving the cleaning article **10** and an elongate handle **72** joined thereto. A typical floor cleaning implement **70** has a handle **72** for grasping by the user and a head **74** attached thereto, and preferably pivotally attached thereto. The head **74** moves against the floor, or other target surface. The cleaning article **10** may be removably attached to the bottom of the head **74**. An attachment system may provide for removable attachment of the cleaning article **10** to a suitable and optional handle **72**. Removable attachment of the cleaning article **10** to the implement **70** may be accomplished using adhesive **32**, hook and loop systems, elongate sleeves, grippers, etc. Grippers and a suitable cleaning implement **70** are disclosed in commonly assigned U.S. Pat. No. 6,484,356.

(156) Referring to FIG. **20B**, the cleaning article **10** may optionally be used with a cleaning solution or other solution usable for other purposes such as treating the surface for appearance or disinfectant, etc. A floor cleaning implement **70** may allow for cleaning of the floor while the user is upright, and may also provide for spraying of cleaning solution or other liquid to the floor from a reservoir **75** through one or more nozzles **76**. Suitable spray implements **70** are disclosed in commonly assigned U.S. Pat. Nos. 5,888,006; 5,988,920; 6,842,936; 7,182,537; 7,536,743; 7,676,877 and 8,186,898. The cleaning solution may be pre-applied to the cleaning article **10**, creating a pre-moistened cleaning article **10** or may be contained within a separate reservoir **75** for dosing onto the cleaning article **10** and/or target surface. The cleaning solution may comprise a majority water, and at least about 0.5, 2, 5 or 10 weight percent solids, or at least about 30 or 50 weight percent aqueous solvents, non-aqueous solutions or mixtures thereof. A suitable implement **70** having an optional vacuum is disclosed in U.S. Pat. No. 7,137,169.

(157) Referring to FIG. **20C**, the implement **70** may have a handle **72** and head **74** used in fixed relationship and comprising one or more tines **73**. The tines **73** may be inserted into sleeves in the cleaning article **10**. This arrangement allows the cleaning article **10** to be conveniently used as a duster for cleaning small object and tight spaces **31**. Suitable implements **70** for a duster type cleaning article **10** are disclosed in commonly assigned U.S. Pat. No. 8,578,564 and D674,949 S.

(158) If desired, the cleaning article **10** may be used with and removably attached to an autonomously moving robot or drone. Suitable examples of robots and drones for use with the cleaning article of the present invention are found in commonly assigned U.S. Pat. Nos. 6,941,199; 6,810,305; 6,779,217; 6,481,515; 6,459,955 and Ser. No. 14/992,195, filed Jan. 11, 2016, P&G Case 14189. Examples of robots for use with wet and dry cleaning are found in U.S. Pat. Nos. 7,389,156; 8,774,966 and 8,855,813. A data control system may be utilized with the cleaning article **10**, as described in U.S. Pat. No. 7,431,524.

(159) The cleaning article **10** may also be used manually, without a handle **72** or implement **70**. If desired, various cleaning articles **10** described herein may be packaged and sold in a kit. This arrangement provides the benefit that the user has a choice of different cleaning articles **10** for different tasks. For example, if desired, plural sizes of the cleaning articles **10** may be sold together as a single kit. This arrangement allows the user to select the particular cleaning article **10** best suited for the immediate task.

(160) The cleaning article **10** may be made according to any of the following nonlimiting paragraphs in any combination thereof. A. A cleaning article **10** bounded by edges **20**, **22** defining an XY plane and a Z-direction perpendicular thereto, said article **10** comprising: a carrier sheet

having a first side and a second side opposed thereto, and a plurality of discrete tow fibers joined to said first side of said carrier sheet by a plurality of primary bonds **32** and extending outwardly therefrom in the Z-direction to have a tow thickness in the z-direction, and at least one elongate secondary bond **34** disposed on at least one plurality of tow fibers and having a secondary bond **34** thickness in the Z-direction, said secondary bond **34** thickness being less than said tow thickness in the Z-direction, said secondary bond **34** bridging at least two adjacent pluralities of tow fibers. B. A cleaning article **10** bounded by alternating longitudinal and transverse edges **20**, **22** defining an XY plane and a Z-direction perpendicular thereto, said article having a longitudinal axis and comprising: a carrier sheet having a first side and a second side opposed thereto, and a plurality of discrete spaced apart tufts **15** of tow fibers joined to said first side of said carrier sheet by a plurality of primary bonds **32** and extending outwardly therefrom in the Z-direction to have a tuft **15** thickness in the Z-direction, and at least one elongate secondary bond **34** disposed in at least one tuft **15** and having a secondary bond **34** thickness in the Z-direction, said secondary bond **34** thickness being less than said tuft **15** thickness, each said secondary bond **34** bridging at least two adjacent tufts **15** of tow fibers. C. A cleaning article **10** bounded by alternating longitudinal and transverse edges **20**, **22** defining an XY plane and a Z-direction perpendicular thereto, having a longitudinal axis and comprising: a carrier sheet having a first side and a second side opposed thereto, and a plurality of discrete spaced apart tufts **15** of tow fibers joined to said first side of said carrier sheet by a plurality of primary bonds **32**, said tufts **15** having at least one secondary bond **34** therethrough creating a channel at least partially through said plurality of tufts **15** in said XY plane. D. A cleaning article **10** according to paragraph A wherein said plurality of tow fibers comprises plural lines of tow fibers. E. A cleaning article **10** according to paragraphs A, B and C wherein said at least one secondary bond **34** comprises a plurality of spaced apart secondary bonds **34**. F. A cleaning article **10** according to paragraphs A, B, C, D and E wherein said at least one secondary bond **34** comprises a plurality of spaced apart secondary bonds **34**, said plurality of spaced apart secondary bonds **34** continuously bridging at least three adjacent pluralities of tow fibers. G. A cleaning article **10** according to paragraphs A, B, C, D, E and F wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, said plurality of secondary bonds **34** being heat sealed secondary bonds **34**. H. A cleaning article **10** according to paragraphs A, B, C, D, E, F and G wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, said plurality of secondary bonds **34** being ultrasonic secondary bonds **34**. I. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G and H wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, said plurality of secondary bonds **34** being of substantially uniform geometry. J. A cleaning article **10** according to paragraph C wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** extending throughout said tow fibers in a direction transverse thereto. K. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I and J wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** being mutually parallel. L. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J and K wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** being rectilinear and extending throughout said plurality of said tow fibers in a direction transverse thereto. M. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K and L wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting an edge **220**, **222** of said plurality of tufts **15** of tow fibers and extending therefrom to a distal end. N. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L and M wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting a respective edge **220**, **222** of said plurality of tufts **15** of tow fibers and extending therefrom to a distal end, said distal

end not being coincident said longitudinal axis. O. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M and N wherein said at least one secondary bond **34** comprises a first plurality of secondary bonds **34** intercepting a first longitudinal edge **220** of said plurality of tufts **15** and extending therefrom to a respective first plurality of distal ends and comprises a second plurality of secondary bonds **34** intercepting a second longitudinal edge **220** of said plurality of tufts **15** and extending therefrom to a plurality of respective second distal ends. P. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M, N and O wherein said at least one secondary bond **34** comprises a first plurality of secondary bonds **34** intercepting a first longitudinal edge **220** of said plurality of tufts **15** and extending therefrom to a respective first plurality of distal ends and comprises a second plurality of secondary bonds **34** intercepting a longitudinal edge **220** of said plurality of tufts **15** and extending therefrom to a respective second plurality of distal ends, said first plurality of secondary bonds **34** and said second plurality of secondary bonds **34** being arranged in a chevron pattern. Q. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M, N and O wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting a said longitudinal edge **220** of said tufts **15** and converging therefrom to a distal end. R. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M, N and O wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting a longitudinal edge **220** of said plurality of tufts **15** and extending therefrom to a distal end, said secondary bonds **34** having a constant width of 2 to 12 mm. S. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M, N and O wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting one longitudinal edge **220** of said plurality of tufts **15** and extending generally perpendicular to said longitudinal axis. T. A cleaning article **10** according to paragraphs A, B, C, D, E, F, G, H, I, J, K, L, M, N and O wherein said at least one secondary bond **34** comprises a plurality of secondary bonds **34**, each said secondary bond **34** of said plurality of secondary bonds **34** intercepting one said longitudinal edge **220** of said plurality of tufts **15** and extending diagonally therefrom.

(161) The dimensions and values disclosed herein are not to be understood as being strictly limited to the exact numerical values recited. Instead, unless otherwise specified, each such dimension is intended to mean both the recited value and a functionally equivalent range surrounding that value. For example, a dimension disclosed as “40 mm” is intended to mean “about 40 mm” and a pressure disclosed as “about 1100 kPa” is intended to include 1103.2 kPa.

(162) Every document cited herein, including any cross referenced or related patent or application, is hereby incorporated herein by reference in its entirety unless expressly excluded or otherwise limited. The citation of any document is not an admission that it is prior art with respect to any invention disclosed or claimed herein or that it alone, or in any combination with any other reference or references, teaches, suggests or discloses any such invention. Further, to the extent that any meaning or definition of a term in this document conflicts with any meaning or definition of the same term in a document incorporated by reference, the meaning or definition assigned to that term in this document shall govern. All limits shown herein as defining a range may be used with any other limit defining a range. That is the upper limit of one range may be used with the lower limit of another range, and vice versa.

(163) While particular embodiments of the present invention have been illustrated and described, it would be obvious to those skilled in the art that various other changes and modifications can be made without departing from the spirit and scope of the invention. It is therefore intended to cover in the appended claims all such changes and modifications that are within the scope of this invention.

## Claims

1. A cleaning article bounded by edges defining an XY plane and a Z-direction perpendicular thereto, said article comprising: a carrier sheet having a first side and a second side opposed thereto, and a plurality of discrete tow fibers joined to said first side of said carrier sheet by a plurality of primary bonds and extending outwardly therefrom in the Z-direction to have a tow thickness in the z-direction, a plurality of slits, wherein said slits extend from one said primary bond to an adjacent said primary bond, and at least one elongate secondary bond disposed on at least one plurality of tow fibers and having a secondary bond thickness in the Z-direction, said secondary bond thickness being less than said tow thickness in the Z-direction, said secondary bond bridging at least two adjacent pluralities of tow fibers that are not joined to said carrier by the same primary bond.
  2. A cleaning article according to claim 1 wherein said plurality of tow fibers comprises plural lines of tow fibers.
  3. A cleaning article according to claim 1 wherein said at least one secondary bond comprises a plurality of spaced apart secondary bonds.
  4. A cleaning article according to claim 1 wherein said at least one secondary bond comprises a plurality of spaced apart secondary bonds, said plurality of spaced apart secondary bonds continuously bridging at least three adjacent pluralities of tow fibers.
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