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Haas et al.

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(54) **INK-RECEPTIVE FOAM ARTICLE**
(75) Inventors: **Christopher K. Haas**, Cottage Grove, MN (US); **Robert D. Taylor**, Stacy, MN (US); **William B. Black**, Eagan, MN (US); **James M. Jonza**, Woodbury, MN (US); **Terrence E. Coopridner**, Woodbury, MN (US)

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(73) Assignee: **3M Innovative Properties Company**, St. Paul, MN (US)

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 361 days.

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Primary Examiner—Betelhem Shewareged
(74) *Attorney, Agent, or Firm*—Kent S. Kokko

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Related U.S. Application Data

(63) Continuation-in-part of application No. 10/502,229, filed as application No. PCT/US03/11255 on Apr. 10, 2003, now abandoned.

(51) **Int. Cl.**
B32B 27/00 (2006.01)

(52) **U.S. Cl.** **428/319.3**; 428/317.9; 428/319.7; 428/314.8; 428/316.6; 428/131; 428/195.1

(58) **Field of Classification Search** 428/319.3, 428/317.9, 319.7, 314.8, 316.6, 131, 195.1
See application file for complete search history.

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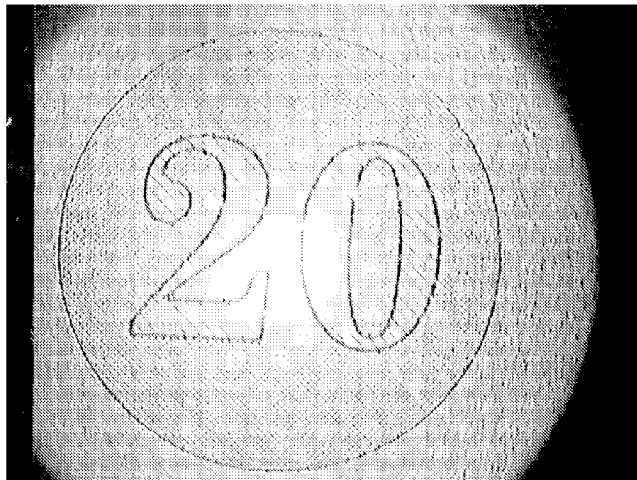
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(57) **ABSTRACT**

The present invention is directed an oriented, foamed article having an ink-receptive surface, and a method of making the article. The invention provides a printable substrate comprising at least one high melt-strength, oriented polypropylene foam layer having an ink-receptive surface. The high melt-strength polypropylene having a melt strength of 25 to 60 cN at 190° C. The ink-receptive surface may comprise and oxidizing treatment, such as corona or flame-treatment of the foam surface, or may comprise an ink-receptive coating, such as a primer coating, on the foam surface.

The oriented foam article is particularly useful in the preparation of printed security documents such as currency, stock and bond certificates, birth and death certificates, land titles and abstracts and the like.

24 Claims, 2 Drawing Sheets



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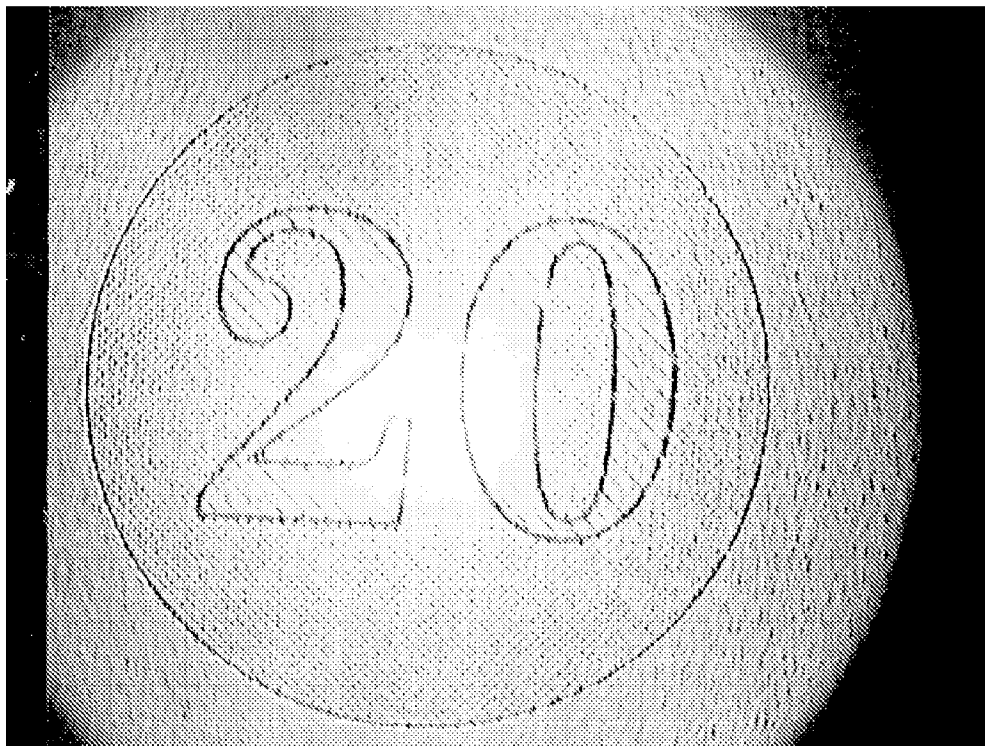


FIG. 1

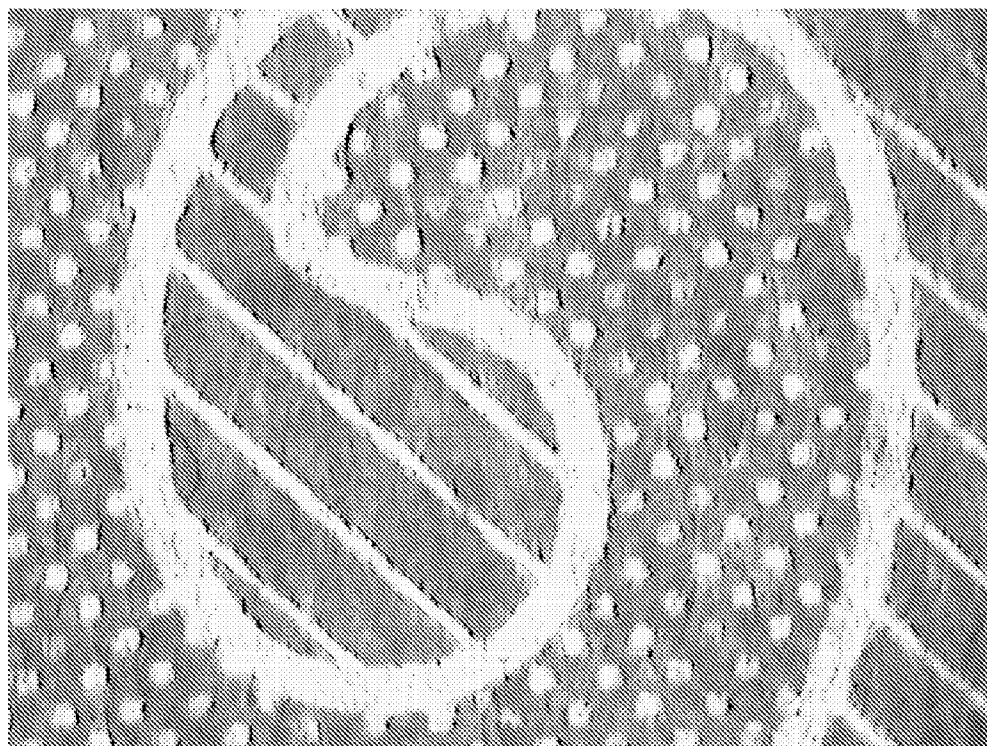


FIG. 2

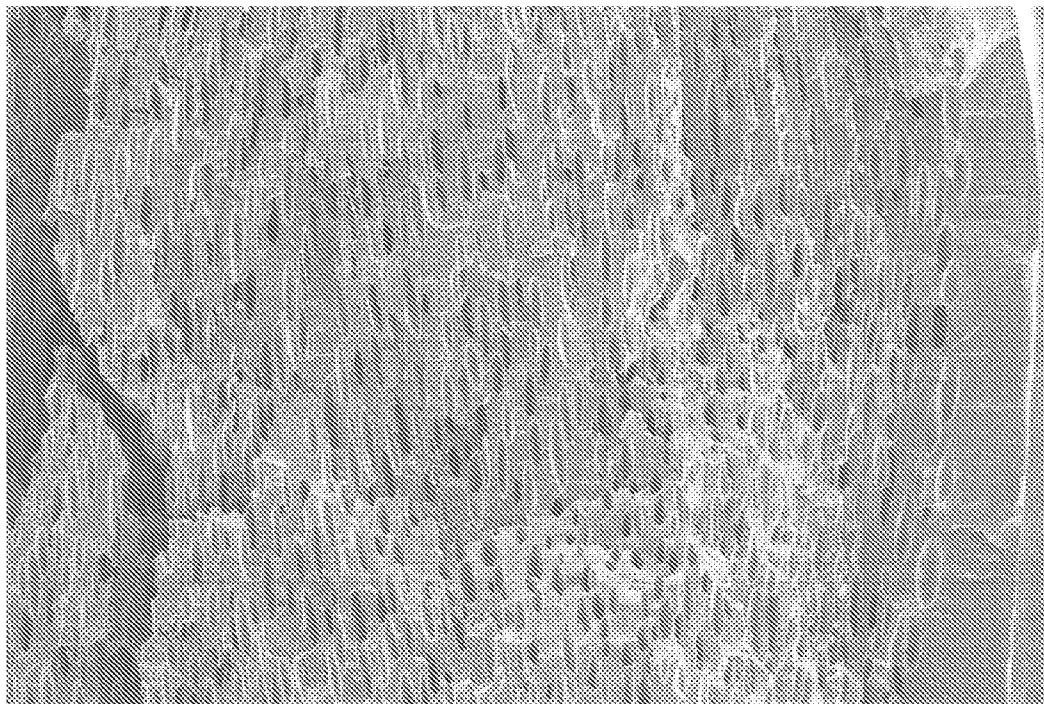


FIG. 3

100 μm

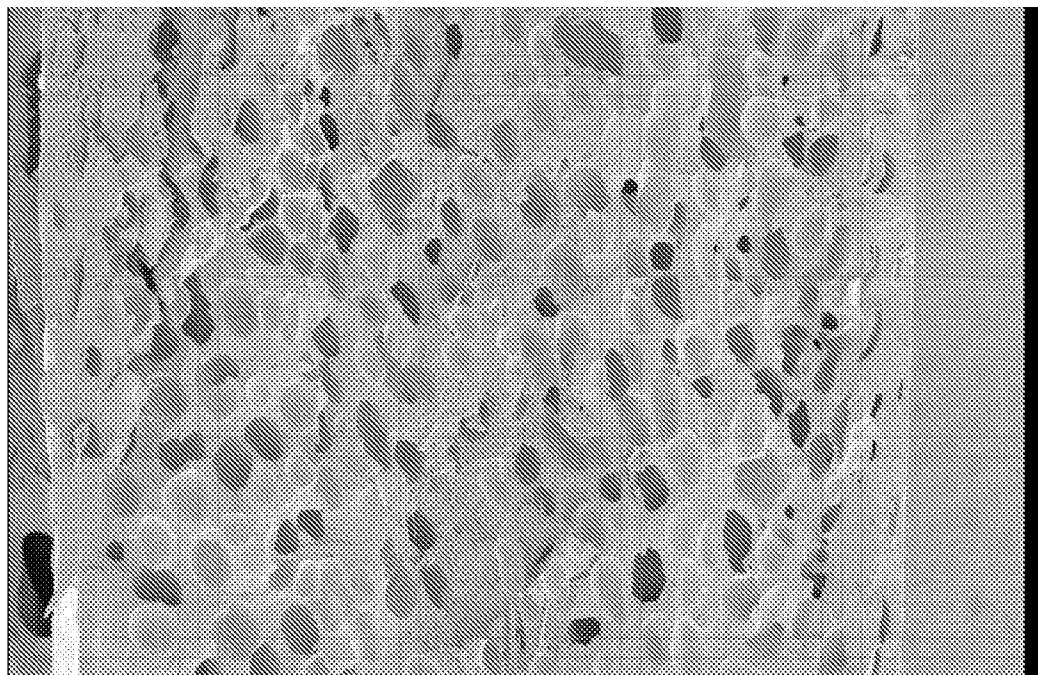


FIG. 4

429 μm

INK-RECEPTIVE FOAM ARTICLECROSS REFERENCE TO RELATED
APPLICATIONS

This application is a continuation-in-part of U.S. application Ser. No. 10/502,229, filed Jul. 21, 2004 now abandoned, which is a national stage filing under 35 U.S.C. 371 of International Application No. PCT/US03/11255, filed Apr. 10, 2003, which International Application was published the International Bureau in English on Dec. 24, 2003 as WO 03/106183, which in turn claims priority to U.S. application Ser. No. 10/175,020, filed Jun. 18, 2002, the disclosure of which is herein incorporated by reference.

FIELD OF THE INVENTION

The present invention is directed to an oriented, foamed article having an ink-receptive surface, and a method of making the article.

BACKGROUND

Many film materials, unlike paper, have no inherent capacity to absorb inks that are commonly used in printing processes. Paper however, is not a particularly durable substrate and may be damaged by handling, environmental exposure and water.

The capture of the image-forming ink on polymeric substrates presents a technical challenge because plastic film is substantially impervious to liquids. Hydrophilic coatings, applied to film materials, are known to provide receptor layers for inkjet images. Receptor layers of this type may be porous for absorbing ink droplets via capillary action. Such coatings are described, for example, in U.S. Pat. No. 5,264,275. An alternative type of absorbent inkjet receptive coating comprises polymers that swell while absorbing image forming ink droplets. Such coatings include those described in U.S. Pat. Nos. 3,889,270, 4,503,111, 4,564,560, 4,555,437, 4,379,804, 5,134,198 and 5,342,688. Hydrophilic inkjet-receptive coatings may also include multilayer coatings as described in U.S. Pat. No. 4,379,804.

For many applications however, polymeric films do not provide the same texture and handling characteristics of paper substrates. Polymeric security documents offer several benefits over their paper counterparts. In particular, polymeric banknotes can offer greatly increased durability and resistance to counterfeiting through the incorporation of security features. A requirement for polymeric banknotes is that certain physical properties are similar to the more commonly used paper banknotes. Those properties relate to tactile feel, strength, tear resistance, handling, folding, and crumple resistance.

U.S. Pat. No. 4,536,016 teaches the use of a laminate for banknotes having biaxially oriented polymeric film and a non-printed window for the incorporation of a security feature. However, U.S. Pat. Nos. 5,698,333 and 5,935,696 discuss the shortcomings of banknotes based on the '016 teachings and offers a substrate construction primarily based on a polyolefin laminate which offers improved physical properties. U.S. Pat. Nos. 5,393,099 and 5,449,200 offer yet another alternative to '016, in which a banknote is described that includes outer layers of paper laminated to a polymeric core as a way to include paper-like properties.

Polymeric banknotes offer unique opportunities to incorporate security features that are designed to discourage counterfeiting. Many patents relating to banknotes, including those cited above, mention the possibility of a transparent

copying techniques. In most cases, the security feature must be added as a separate component with an additional process step.

U.S. Pat. No. 5,234,729 teaches polymeric laminates having a large number of layers and exhibiting optically unique properties. The '729 patent even suggests that the subject of that patent could be formed into plastic currency but fails to address the physical properties required for that application. See additional references U.S. Pat. Nos. 4,162,343, 4,937,134, and 5,089,318. U.S. Pat. No. 6,045,894 teaches multilayered optical films with unique optical properties that can be used as security features on certain documents of value but also fails to teach the necessary embodiments for such a film to be useful as a banknote, particularly having those physical properties required of a banknote.

SUMMARY OF THE INVENTION

The invention provides a printable substrate comprising at least one oriented, high melt-strength polypropylene foam layer having an ink-receptive surface. The ink-receptive surface may comprise an oxidizing treatment, such as corona or flame-treatment of the foam surface, or may comprise an ink-receptive coating, such as a primer coating, on the foam surface, or may comprise a laminated or coextruded polymer film that is ink-receptive.

The invention further provides a multilayer article comprising at least one oriented, high melt strength foam layer and at least one non-foam layer. Preferably the non-foam layer is a thermoplastic film layer. In such multilayer article constructions comprising foam and thermoplastic film layer(s), either the foam layer or the film layer may have an ink-receptive surface thereon. Preferably, the multilayer construction comprises two oriented, high melt strength polypropylene foam layers and a thermoplastic film layer disposed between the foam layers. More preferably, the thermoplastic film layer comprises a thermoplastic polymer that imparts stiffness to the multilayer article.

The invention further provides a method of making the printable substrate by the steps of providing an oriented, high melt-strength polypropylene foam, and providing an ink-receptive surface on at least one major surface of the foam

The present invention also provides a method of preparing an ink-receptive, multilayer article comprising at least one high-melt strength polypropylene foam layer and at least one thermoplastic film layer. Either the foam layer or the film layer may have an ink-receptive surface thereon. The multilayer article may be prepared by separately preparing the foam and film layers, and laminating, bonding or otherwise affixing them together, or the separate layers may be coextruded into a multilayer article. If the film layer(s) constitute an outermost layer, as in a film/foam/film construction, the film layer(s) may be treated to render them ink-receptive such as by corona or an ink-receptive coating, or the thermoplastic film layer may be inherently ink-receptive.

The oriented foam article is particularly useful in the preparation of printed security documents such as currency, stock and bond certificates, birth and death certificates, checks, titles and abstracts and the like.

Polymeric documents offer several benefits over their paper counterparts. In particular, polymeric security documents can offer greatly increased durability and resistance to counterfeiting through the incorporation of security features. A requirement for some polymeric security documents is that certain physical properties are similar to the more commonly used paper banknotes. Those properties relate to tactile feel, strength, tear resistance, handling, folding, and crumple resistance.

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