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ATHLETIC BRA

Abstract

An athletic bra includes a front panel, a rear panel, a first strap, a second strap, and an underband coupled to the front panel and the rear panel. The first strap and the second strap connect the front panel to the rear panel. The front panel includes an outer shell and an inner layer, and a first cup and a second cup are positioned within the front panel. At least one of the first cup and the second cup is coupled to at least one of the outer shell and the inner layer, such that the at least one of the first cup and the second cup is not removable.

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Background/Summary

CROSS REFERENCE TO RELATED APPLICATIONS [0001] This application is a continuation of U.S. application Ser. No. 17/747,765, filed on May 18, 2022, entitled “Athletic Bra,” which claims priority to U.S. Provisional Patent Application No. 63/191,082, filed on May 20, 2021, entitled “Athletic Bra,” each of which are incorporated by reference herein in their entirety and are to be considered a part of this application.

REFERENCE REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable

SEQUENCE LISTING

[0003] Not applicable

BACKGROUND

1. Field of the Invention

[0004] The present disclosure relates generally to an athletic bra constructed to provide support for high impact performance.

2. Description of the Background

[0005] Many conventional athletic bras, or sports bras, generally comprise a material that covers and supports a wearer's breasts during, for example, athletic activities. In particular, athletic bras are generally configured to support the breasts to help protect breast tissue from damage and/or stretching during motion. High impact athletic bras are often used for high impact or high intensity activities, such as those that may result in excessive bouncing, potentially resulting in subsequent damage and/or stretching of breast tissue and/or pain. Such issues can be exacerbated for subjects with larger breasts.

[0006] In order to provide suitable support, high impact sports bra in the market usually include an underwire made of metal or hard plastic to support the breasts, inflexible or rigid molded cups to encapsulate and hold the breasts in place, thus helping restrict movement, and/or compression to press the breasts toward the body and further restrict movement. However, current high impact bras are often not comfortable and/or are not constructed with a focus on reducing breast momentum.

[0007] Therefore, athletic bras for high impact performance having features capable of reducing breast momentum without sacrificing comfort may be desired.

SUMMARY

[0008] An athletic bra, as described herein, may have various configurations. In some embodiments, an athletic bra is provided comprising a front panel, a rear panel, a first strap and a second strap connecting the front panel to the rear panel, and an underband coupled to the front panel and the rear panel. The front panel, the rear panel, the first strap, the second strap, and the underband comprise an outer shell, and the outer shell includes a fabric comprising polyamide and spandex. The athletic bra also includes a first cup and a second cup positioned within the front panel, where the first cup and the second cup each comprise a first layer and a second layer coupled together by an adhesive.

[0009] In some embodiments, the first layer is a foam material and the second layer is a double knit fabric. Furthermore, in some embodiments, the adhesive is polyurethane hot melt. In some embodiments, the fabric comprises between about 60-65% polyamide and between about 35-40% spandex. In further embodiments, the fabric comprises 63% polyamide and 37% spandex.

[0010] In some embodiments, the front panel, the rear panel, the first strap, the second strap, and the underband comprise the outer shell and an inner layer, and the first cup and the second cup are coupled to one of the outer shell and the inner layer. Furthermore, the first cup and the second cup

may each be configured to extend upward from the underband toward a neck opening defined by the front panel. Additionally, in some embodiments, the outer shell and the inner layer are coupled together to form a seamless edge.

[0011] In some embodiments, the front panel is sized to fully cover breasts of a wearer. In further embodiments, the front panel defines a central axis, and a total height of the front panel and the underband along the central axis of about 18 centimeters. In some embodiments, the underband includes a height of about 3.8 centimeters. In some embodiments, the first strap and the second strap each includes a uniform width along its length, wherein the width is about 3.5 centimeters. In other embodiments, the first strap and the second strap each includes a varying width along its length. In some embodiments, the first strap and the second strap each include an adjustable length. In some embodiments, the underband includes an adjustable circumference.

[0012] Some embodiments provide an athletic bra comprising an outer shell, an inner layer, a first cup, and a second cup. The outer shell is configured to lay distal from a wearer when the athletic bra is worn, and the inner layer is configured to lay more proximal to the wearer than the outer shell when the athletic bra is worn. At least one of the outer shell and the inner layer includes a fabric comprising polyamide and spandex. The first cup and the second cup are positioned between the outer shell and the inner layer, and each comprise a first layer and a second layer coupled together by an adhesive.

[0013] In some embodiments, the first layer is a foam material and the second layer is a double knit fabric. Furthermore, in some embodiments, the adhesive is polyurethane hot melt. In some embodiments, the fabric comprises between about 60-65% polyamide and between about 35-40% spandex. In further embodiments, the fabric comprises 63% polyamide and 37% spandex.

[0014] In some embodiments, the outer shell and the inner layer are coupled together to form a front panel, a rear panel, a first strap and a second strap connecting the front panel to the rear panel, and an underband coupled to the front panel and the rear panel. In some embodiments, the front panel, the rear panel, the first strap, and the second strap comprise an outer edge that defines a neck opening, and the outer shell and the inner layer are bonded together at the outer edge.

[0015] Other aspects of the athletic bra described herein, including features and advantages thereof, will become apparent to one of ordinary skill in the art upon examination of the figures and detailed description herein. Therefore, all such aspects of the athletic bras are intended to be included in the detailed description and this summary.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is a front view of an athletic bra according to some embodiments;

[0017] FIG. 2 is a rear view of the athletic bra of FIG. 1;

[0018] FIG. 3A is a chart of results from a study of breast movement (vertical nipple displacement) during running, comparing the athletic bra of FIG. 1 having a two-layer breast cup and a control bra;

[0019] FIG. 3B is a chart of results from a study of breast movement (lateral nipple displacement) during running, comparing the athletic bra of FIG. 1 having a two-layer breast cup and a control bra;

[0020] FIG. 4A is a chart of results from a study of vertical grain elongation and modulus at 7.5 pound-force, comparing a first outer shell fabric type, a second outer shell fabric type, a third outer shell fabric type, and a fourth outer shell fabric type;

[0021] FIG. 4B is a chart of results from a study of horizontal grain elongation and modulus at 7.5 pound-force, comparing a first outer shell fabric type, a second outer shell fabric type, a third outer shell fabric type, and a fourth outer shell fabric type;

[0022] FIG. 5A is a chart of results from a study of breast movement (vertical nipple displacement) during running, comparing the athletic bra of FIG. 1 having a first outer shell fabric type, an athletic bra having a second outer shell fabric type, an athletic bra having a third outer shell fabric type, an athletic bra having a fourth outer shell fabric type, and a control bra;

[0023] FIG. 5B is a chart of results from a study of breast movement (lateral nipple displacement) during running, comparing the athletic bra of FIG. 1 having a first outer shell fabric type, an athletic bra having a second outer shell fabric type, an athletic bra having a third outer shell fabric type, an athletic bra having a fourth outer shell fabric type, and a control bra;

[0024] FIG. 6A is a chart of results from a study of breast movement (vertical nipple displacement) during running, comparing the athletic bra of FIG. 1 having an 18-centimeter front panel height, an athletic bra having a 16-centimeter front panel height, and a control bra;

[0025] FIG. 6B is a chart of results from a study of breast movement (lateral nipple displacement) during running, comparing the athletic bra of FIG. 1 having an 18-centimeter front panel height, an athletic bra having a 16-centimeter front panel height, and a control bra;

[0026] FIG. 7A is a chart of results from a study of breast movement (vertical nipple displacement) during running, comparing the athletic bra of FIG. 1 having a bonded-edge neck opening, an athletic bra having cut-and-sewn edge neck opening, and a control bra;

[0027] FIG. 7B is a chart of results from a study of breast movement (lateral nipple displacement) during running, comparing the athletic bra of FIG. 1 having a bonded-edge neck opening, an athletic bra having cut-and-sewn edge neck opening, and a control bra; and

[0028] FIG. 8 is a cross sectional view of a cup of the athletic bra of FIG. 1.

DETAILED DESCRIPTION OF THE DRAWINGS

[0029] The following discussion and accompanying figures disclose various embodiments or configurations of an athletic bra. Although embodiments are disclosed with reference to an athletic bra for high impact activities, such as running, intensive training, elliptical, dancing, mounting biking, jumping, etc., concepts associated with the embodiments of the athletic bra may be applied to a wide range of bra and bra styles, including mid-intensity activities such as cycling and skiing, low-intensity activities such as walking, yoga, and strength training, or loungewear, for example. Accordingly, concepts described herein may be utilized in a variety of products.

[0030] The term “about,” as used herein, refers to variation in the numerical quantity that may occur, for example, through typical measuring and manufacturing procedures used for athletic bras or other articles of manufacture that may include embodiments of the disclosure herein; through inadvertent error in these procedures; through differences in the manufacture, source, or purity of the ingredients used to make the compositions or mixtures or carry out the methods; and the like. Throughout the disclosure, the terms “about” and “approximately” refer to a range of values $\pm 5\%$ of the numeric value that the term precedes.

[0031] The present disclosure is directed to an athletic bra and/or specific components of the athletic bra. For example, FIGS. 1 and 2 depict an athletic bra 10 according to some embodiments. As described in further detail below, in some embodiments, the athletic bra 10 can include one or more features that, alone or in combination, minimizes breast movement and momentum during high intensity movements, such as running, jumping, dancing, elliptical, mountain biking, or other high intensity training.

[0032] Referring to FIGS. 1 and 2, generally, the athletic bra 10 can include a front 12 (shown in FIG. 1), a rear 14 (shown in FIG. 2), a top 16, a bottom 18, a first side 20, and a second side 22. When worn, the front 12 can coincide with a wearer's front torso 24, the rear 14 can coincide with the wearer's rear torso 26, the top 16 can coincide with the wearer's chest 28, back 30, and shoulders 32, and the bottom 18 can coincide with the wearer's mid-torso 34, such as the rib cage below the breasts 36, the first side 20 can coincide with a first lateral side of the wearer, such as the wearer's left side, and the second side can coincide with a second, opposite lateral side of the wearer, such as wearer's right side. However, in some embodiments, the first side 20 and the second

side **22** may instead coincide with the wearer's right side and left side, respectively.

[0033] Still referring to FIGS. **1** and **2**, the athletic bra **10** can include a front panel **38** (shown in FIG. **1**), two straps **40**, **42**, a rear panel **44** (shown in FIG. **2**), two cups **46** (shown in FIG. **2**), and an underband **48**. The front panel **38** is configured to overlay a portion of the front torso **24** of the wearer, covering the breasts **36** and a portion of the chest **28**. The rear panel **44** is configured to overlay a portion of the rear torso **26** of the wearer, and may be coupled to the front panel **38** directly and via the straps **40**, **42** and the underband **48**. For example, the straps **40**, **42** may be coupled to the front panel **38** and extend over the shoulders **32** of the wearer to the rear panel **44**, thus connecting the front panel **38** to the rear panel **44**. The underband **48** is configured to extend around the wearer's mid-torso **34**, underneath the breasts **36**, and be coupled to bottom portions of the front panel **38** and the rear panel **44**. Additionally, in some embodiments, the front panel **38** and the rear panel **44** may comprise one contiguous piece, or may be separate pieces coupled, e.g., stitched or bonded, together along the first and second sides **20**, **22**, or may be a composition of multiple layers, some being continuous and some being coupled together. Furthermore, in some embodiments, the front panel **38** and the rear panel **44** may be indirectly coupled together via separate side panels (not shown) that are configured to overlay portions of the side torso of the wearer, e.g., under the armpits **50**. Additionally, in some embodiments, the front panel **38** and/or the rear panel **44**, and/or the straps **40**, **42** may comprise one contiguous piece, or may be separate pieces coupled, e.g., stitched or bonded, together, or may be a composition of multiple layers, some being continuous and some being coupled together.

[0034] In some embodiments, referring to FIGS. **1** and **2**, the athletic bra **10** can comprise one or more layers, including at least an outer shell **52**. The outer shell **52** may be a layer of fabric most distal from the wearer when the athletic bra **10** is worn. Further, in some embodiments, the athletic bra **10** can comprise the outer shell **52** and an inner layer, such as an inner shell **54** (shown in FIG. **2**) configured to be the most proximate layer to the wearer, e.g., contacting the wearer, when the athletic bra **10** is worn. In other words, when the athletic bra **10** is worn, the outer shell **52** is configured to face away from the wearer and the inner shell **54** is configured to face toward the wearer. Furthermore, in some embodiments, the athletic bra **10** can comprise the outer shell **52** and multiple inner layers, such as the inner shell **54** and one or more mid-layers (not shown) located between the outer shell **52** and the inner shell **54**. As such, in some embodiments, the outer shell **52** and the inner shell **54** may be collectively considered an "outer shell" as these layers make up the outer layers of the athletic bra **10**, in contrast to the inner layers therebetween.

[0035] Each layer, i.e., the outer shell **52**, the inner shell **54**, and any mid-layers, can comprise the same fabric type, or varying fabric types. For example, in some embodiments, one or more layers can have different properties from other layers. Additionally, the front panel **38**, the underband **48**, and/or other components can include additional components coupled to or arranged between one of the layers. For example, as shown in FIG. **2**, the cups **46** can be coupled to the inner shell **54**, or an innermost layer, of the front panel **38**, or coupled in between layers of the front panel **38**. In some embodiments, the cups **46** can be coupled to the inner shell **54**, and/or a mid-layer, and/or the outer shell **52** of the front panel **38**. Generally, each cup **46** can be positioned along the front panel **38** over a nipple area **56** (shown in FIG. **2**) and its periphery. As further described below, in some embodiments, each cup **46** can extend upward from the underband **48**. Additionally, in some embodiments, the underband **48** can incorporate one or more elastic bands therein (not shown) so that the underband **48** compresses around the mid-torso **34** to help secure the athletic bra **10** in place and support the breasts **36**.

[0036] Referring still to FIGS. **1** and **2**, the front panel **38**, the rear panel **44**, the straps **40**, **42**, and the underband **48** can be formed together to define a neck opening **58** at the top **16**, a first arm opening **60** along the first side **20**, a second arm opening **62** along the second side **22**, a torso opening **64** at the bottom **18**, and, optionally, a rear opening **66** (shown in FIG. **2**) at the rear **14** between the rear panel **44** and the underband **48**. The relative arrangement and size of these

components can define different styles and support types of the athletic bra **10**.

[0037] For example, as noted above and referring to FIG. **1**, generally, the front panel **38** can extend upward from the underband **48** to the neck opening **58** to cover the breasts **36** and chest **28** of the wearer. The front panel **38** can extend a minimal height **H1** at its center (aligned with a central axis **68**) that defines a coverage type of the athletic bra **10**. More specifically, in some applications, a height **H1** that is well below armpit level and/or does not fully cover the breasts **36** when worn may be considered a low-coverage or low-cut athletic bra. A height **H1** that is generally aligned with or rises above the armpits **50** and fully covers the breasts **36** when worn may be considered a full-coverage or high-cut athletic bra. And a height **H1** higher than a low-cut, but still not fully covering the breasts **36** when worn may be considered a mid-cut athletic bra. A full-coverage athletic bra **10** can provide more support than a low-coverage or mid-cut athletic bra as fuller coverage of the breasts can reduce movement and, as a result, restrict bounce.

[0038] Referring to FIG. **2**, generally, the rear panel **44** can extend upward from the underband **48** to the neck opening **58**. In the embodiment illustrated in FIG. **2**, the rear panel **44** forms a “T-shape” before joining the straps **40**, **42** to define a racer-back style athletic bra **10**. In such a style, the rear panel **44** and the straps **40**, **42** generally do not cover the wearer's shoulder blades. In some embodiments, the rear panel **44** may instead form a generally rectangular shape, in which the straps **40**, **42** extend downward and cross over each other before joining the rear panel **44**, thus defining a crisscross style athletic bra. In yet other embodiments, the rear panel **44** may form the generally rectangular shape, in which the straps **40**, **42** extend straight downward from the shoulders **32** to join the rear panel **44**, thus defining a tank-top style athletic bra. In yet other embodiments, the athletic bra **10** may not include a rear panel and the straps **40**, **42** can extend down (in a crisscross style or tank-top style) to join the underband **48**. Additionally, the rear panel **44**, in a T-shape or rectangular shape, can include a constant bottom section that is coupled to the underband **48**, or can include an interrupted bottom section coupled to the underband **48**, as shown in FIG. **2**. The interrupted bottom section can, with the underband **48**, define the rear opening **66**, as shown in FIG. **2**.

[0039] Referring still to FIG. **2**, generally, the underband **48** can extend circumferentially around the wearer's torso **34** and be coupled to the front panel **38** and the rear panel **44**. As noted above, in some embodiments, the underband **48** can further incorporate one or more elastic bands extending therethrough, or include fabrics with sufficiently elasticity, to help tension the underband **48** around the wearer's torso **34**. Furthermore, in some embodiments, the underband **48** may continuously extend an entire circumference of the athletic bra **10**. As a result, in such embodiments, the underband **48** can have a constant or non-adjustable circumference. However, in other embodiments, the underband **48** may discontinuously extend the entire circumference. More specifically, as shown in FIG. **2**, rear ends **70**, **72** of the underband **48** can be coupled together by, for example, a hook and eye closure (not shown). For example, a first rear end **70** of the underband **48** can include one hook or a set of hooks, while a second rear end **72** of the underband **48** can include one eye or a set of eyes configured to receive the hooks. Furthermore, in some embodiments, the underband **48** can have an adjustable circumference by incorporating a plurality of eyes (or sets of eyes) at different locations distanced from an edge of the rear end **72**, thus providing different locations to receive the hooks. In this manner, the underband **48** may be adjustable in that a wearer can further tighten the underband **48** around their torso **34** by adjusting the hook and eye closure.

[0040] Referring again to FIGS. **1** and **2**, each strap **40**, **42** can extend from the front panel **38** along the front **12**, to the rear panel **44** along the rear **14**. In some embodiments, as shown in FIGS. **1** and **2**, the straps **40**, **42** can have a generally uniform or constant width **W1** along their full length. However, in other embodiments, the straps **40**, **42** may have a varying width **W1** along their lengths. Additionally, in some embodiments, as shown in FIGS. **1** and **2**, the straps **40**, **42** can have a constant length **L1**. However, in other embodiments, the straps **40**, **42** can have a variable or

adjustable length L1, for example, by incorporating adjustment slides (not shown).

[0041] As noted above, the athletic bra **10** of some embodiments can incorporate one or more features that, alone or in combination, improve support of the wearer's breasts **36** during use, for example, in high intensity or high impact activities. The features may enhance support by reducing breast movement and momentum during activities. Reduction in breast movement can be quantitatively analyzed by monitoring nipple movement during activity, for example, as vertical displacement (or y-axis displacement) from original nipple position to clavicle in a percentage, where original nipple position is designated as 100% (considered two-dimensional displacement metrics or "2D metrics"). Reduction in breast movement can further be quantitatively analyzed by monitoring nipple movement during activity, for example, as "lateral displacement" or a sum of displacements, e.g., along x, y, and z axes, between original nipple position and clavicle (considered three-dimensional displacement metrics or "3D metrics"). The features of some embodiments are discussed below with respect to these quantitative assessments.

[0042] Referring to FIG. 2, in some embodiments, each cup **46** can be "built in" to the front panel **38**, e.g., directly coupled to the inner shell **54** or to a mid-layer of the front panel **38**. For example, a built-in cup **46** of some embodiments may be in contrast to removable cups that can be inserted and removed in between layers or permanent "floating" cups that are not directly coupled to a particular layer but, rather, are positioned between layers yet still movable. As shown in FIG. 2, each cup **46** can extend upward from the underband **48** to a location adjacent but spaced apart from the neck opening **58**, with a curved or semi-circular top end **74**, in order to separately encapsulate a respective breast **36**. Each cup **46** can further extend from a location adjacent the central axis **68** along the front panel **38** to a location adjacent the respective side **20**, **22**. For example, an outer perimeter **76** of the cup **46** can extend from the underband **48** adjacent the central axis **68** generally vertically upward, then start to curve until reaching the curved top end **74**, then generally follow a curve of the side opening **60**, **62**, before extending straight vertically downward back to the underband **48** adjacent the respective side **20**, **22**.

[0043] Still referring to FIG. 2, each cup **46** can include two layers of fabric configured to directly overlay the nipple area **56** and its periphery, such as a first layer **77** and a second layer **78** (see FIG. 8). In some embodiments, the first layer can be a foam material and the second layer can be a double knit fabric. In other embodiments, the first layer can be a double knit fabric and the second layer can be a foam material. For example, the foam material can be a polyurethane foam material. As another example, the foam material can be a combination of spacer foam (such as spacer foam comprised of polyester and elastane) and a double knit fabric (such as knit fabric comprised of polyester and elastane, or spandex). As a specific example, the foam material can be a combination of spacer foam, comprised of 46% 75 denier ("D") polyester, 44% 60D polyester, and 10% 40D elastane, and double knit fabric, comprised of 85% polyester and 16% spandex. Furthermore, the first layer and the second layer can be coupled or fixed together with a medium in a specific pattern. For example, in some embodiments, the first layer **77** and the second layer **78** can be coupled together using an adhesive **79** such as polyurethane hot melt ("PUR"), also called reactive hot melt, reactive polyurethane, polyurethane reactive, or RPU adhesive). In contrast to inflexible molded cups that encapsulate the breasts **36**, the present cup materials (comprising foam and double knit fabric) can provide a soft, flexible mold cup.

[0044] The construction of the cup **46** and pattern of the coupling can help absorb the energy of breast bounces and reduce momentum during activity. For example, referring to FIGS. 3A and 3B, a study was conducted of a wearer (size 34D) wearing the athletic bra **10** with the cup **46** described above, i.e., with the two-layer, foam and double knit fabric composition coupled together with PUR, and an existing athletic bra providing a control cup, while running at 7 kilometers per hour (km/hr) and 10 km/hr. FIG. 3A illustrates resulting 2D metrics measured from the cup **46** described above (line **80**) and the control cup (line **82**). As shown in FIG. 3A, the wearer experienced a 115.5% displacement and a 118.3% displacement with the cup **46** described above when running at

7 km/hr and 10 km/hr, respectively, and the wearer experienced a 116% displacement and a 123.6% displacement with the control cup when running at 7 km/hr and 10 km/hr.

[0045] Furthermore, FIG. 3B illustrates resulting 3D metrics measured from the cup **46** described above (line **84**) and the control cup (line **86**). As shown in FIG. 3B, the wearer experienced a 13.07 millimeter (mm) displacement and a 16.46 mm displacement with the cup **46** described above when running at 7 km/hr and 10 km/hr, respectively, and the wearer experienced a 13.93 mm displacement and a 20.44 mm displacement with the control cup when running at 7 km/hr and 10 km/hr. In particular, specific 3D metrics show that the cup **46** described above can reduce breast displacement while the wearer runs at 10 km/hr by 5% in the vertical (y-axis or up-and-down) direction and by 19% in the lateral (x-axis or side-to-side) direction. As shown in the results of FIGS. 3A and 3B, the construction of the cup **46** and pattern of the coupling of the athletic bra **10**, according to some embodiments, can reduce breast movement during activity compared to other cups.

[0046] Referring back to FIGS. 1 and 2, as noted above, the athletic bra **10** can comprise one or more layers, including at least an outer shell **52**. In some embodiments, the outer shell **52** can comprise a fabric made of a combination of polyamide and spandex, such as between about 60-65% polyamide and between about 35-40% spandex. In some embodiments, the outer shell **52** can be made of a fabric comprising 63% polyamide and 37% spandex, with a weight of about **345** grams per square meter (g/m²). This combination, with a suitable percentage of spandex, provides sufficient support and comfort. It should be noted that spandex may also be referred to as elastane, elastic synthetic fiber, polyether-polyurea copolymer, etc. In some embodiments, the spandex may be Lycra®.

[0047] Furthermore, this combination of polyamide and spandex of some embodiments provides a soft, comfortable four-way stretch. For example, FIGS. 4A and 4B illustrate a comparison of vertical grain elongation and modulus at 7.5 pound-force (lbf) and horizontal grain elongation and modulus at 7.5 lbf, respectively, between the present shell fabric described above (63% polyamide and 37% spandex) and three other types of fabric (“fabric A,” “fabric B,” and “fabric C”). Fabric A was comprised of 76% polyester and 24% spandex, weighing 290 g/m², Fabric B was comprised of 77% polyester and 23% spandex, weighing 250 g/m², and Fabric C was comprised of 75% polyester and 25% spandex, weighing 225 g/m². As shown in FIG. 4A, the present fabric (represented at line **88**) illustrated a higher vertical grain modulus than fabrics B and C (line **90** and **92**, respectively) from 20%-80% elongation, and a higher vertical grain modulus than fabric A (line **94**) from 20%-60%. Furthermore, as shown in FIG. 4B, the present fabric (represented at line **96**) illustrated a higher horizontal grain modulus than all of fabrics A, B, and C (line **98**, **100**, and **102**, respectively) from 20%-80% elongation.

[0048] The higher modulus of the present outer shell fabric can provide better support to reduce breast bouncing during activity. For example, referring to FIGS. 5A and 5B, a study was conducted of a wearer (size 34D) wearing the athletic bra **10** with the outer shell fabric described above (63% polyamide and 37% spandex), an athletic bra comprising fabric A, an athletic bra comprising fabric B, an athletic bra comprising fabric C, and an existing athletic bra providing a control fabric, while running at 7 km/hr and 10 km/hr. FIG. 5A illustrates resulting 2D metrics measured from the bras having the present outer shell fabric (line **104**), fabric A (line **106**), fabric B (line **108**), fabric C (line **110**), and the control fabric (line **112**). As shown in FIG. 5A, at 7 km/hr, the wearer experienced a 115.5% displacement with the present shell fabric described above, a 118.6% displacement with fabric A, a 119.00% displacement with fabric B, a 119.2% displacement with fabric C, and a 123.2% displacement with the control fabric. At 10 km/hr, the wearer experienced a 118.3% displacement with the present shell fabric, a 123.2% displacement with fabric A, a 127.6% displacement with fabric B, a 125% displacement with fabric C, and a 132.2% displacement with the control fabric.

[0049] Furthermore, FIG. 5B illustrates resulting 3D metrics measured from the bras having the

present outer shell fabric (line **114**), fabric A (line **116**), fabric B (line **118**), fabric C (line **120**), and the control fabric (line **122**). As shown in FIG. **5B**, at 7 km/hr, the wearer experienced a 13.07 mm displacement with the present shell fabric described above, a 15.83 mm displacement with fabric A, a 17.23 mm displacement with fabric B, a 17.19 mm displacement with fabric C, and a 20.67 mm displacement with the control fabric. At 10 km/hr, the wearer experienced a 16.46 mm displacement with the present shell fabric, a 20.23 mm displacement with fabric A, a 24.48 mm displacement with fabric B, a 22.62 mm displacement with fabric C, and a 26.54 mm displacement with the control fabric. As shown in the results of FIGS. **5A** and **5B**, the composition of the outer shell fabric, according to some embodiments, can reduce breast movement, i.e., reduce lateral and vertical displacement, during activity compared to other fabrics. In light of these results, the outer shell fabric of some embodiments can be suitable for high-impact activities. Furthermore, in some applications, fabric A may also be suitable for high-impact activities, though it exhibits larger lateral and vertical breast displacement than the present shell fabric.

[0050] Referring back to FIG. **1**, in some embodiments, the height **H1** of the front panel **38** (shown in FIG. **1**) can coincide with a full-coverage configuration. For example, in some embodiments, for a size small, the “total height” of the athletic bra **10**, including the height **H1** of the front panel **38** plus a height **H2** of the underband **48** (shown in FIGS. **1** and **2**), measured along the central axis **68**, can be at least about 18 centimeters (cm) to provide full-coverage for high impact activities. In contrast, a size small mid-impact activity athletic bra can include a total height of at least about 15 cm. Generally, different-size athletic bras **10**, e.g., small, medium, large, extra-large, etc., can include at least a different height **H1** so that the total height provides full-coverage for different-sized breasts. As noted above, a full-coverage athletic bra **10** can provide more support than a mid- or low-coverage athletic bra as fuller coverage of the breasts can reduce movement and, as a result, restrict bounce.

[0051] By way of example, referring to FIGS. **6A** and **6B**, a study was conducted of a wearer (size 34D) wearing the athletic bra **10** of some embodiments with a front panel **38** having a height of 18 cm, the athletic bra with a front panel having a height of 16 cm, and an existing athletic bra providing a control bra, while running at 7 km/hr and 10 km/hr. FIG. **6A** illustrates resulting 2D metrics measured from the bras having a height **H1** of 18 cm (line **124**), height **H1** of 16 cm (line **126**), and the control bra (line **128**). As shown in FIG. **6A**, at 7 km/hr, the wearer experienced a 115.5% displacement with the 18-cm front panel bra, a 114.2% displacement with the 16-cm front panel bra, and a 123.2% displacement with the control bra. At 10 km/hr, the wearer experienced a 118.3% displacement with the 18-cm front panel bra, a 123% displacement with the 16-cm front panel bra, and a 132.2% displacement with the control bra.

[0052] Furthermore, FIG. **6B** illustrates resulting 3D metrics measured from the bras having a height **H1** of 18 cm (line **130**), height **H1** of 16 cm (line **132**), and the control bra (line **134**). As shown in FIG. **6B**, at 7 km/hr, the wearer experienced a 13.07 mm displacement with the 18-cm front panel bra, a 12.81 mm displacement with the 16-cm front panel bra, and a 20.67 mm displacement with the control bra. At 10 km/hr, the wearer experienced a 16.46 mm displacement with the 18-cm front panel bra, a 20 mm displacement with the 16-cm front panel bra, and a 26.54 mm displacement with the control bra. As shown in the results of FIGS. **6A** and **6B**, while the present bra with full coverage is similar to an equivalent mid-coverage bra for certain activities, the present bra with full coverage provides significantly more breast control, i.e., reducing lateral and vertical displacement, during higher intensity activities.

[0053] Referring back to FIG. **1**, as noted above, the athletic bra **10** can comprise multiple layers of fabric, including at least the outer shell **52**. Further, the layers can be coupled together along one or more edges. In some embodiments, the layers of the athletic bra **10** can be bonded together at an outer edge **136** (shown in FIGS. **1** and **2**) defining the neck opening **58**, an outer edge **138** (shown in FIGS. **1** and **2**) defining the first arm opening **60**, an outer edge **140** (shown in FIGS. **1** and **2**) defining the second arm opening **62**, and/or an outer edge **142** (shown in FIG. **2**) defining the rear

opening **66**. In some embodiments, an entire outer edge **136, 138, 140, 142** of each opening **58, 60, 62, 66** is bonded. In other embodiments, a portion of the outer edge **136, 138, 140, 142** of each opening **58, 60, 62, 66** is bonded. These bonded, or seamless, edges **136, 138, 140, and/or 142** can provide necessary strength to hold the layers together while also adding less bulk and providing smooth edges to minimize chafing during movement, for example, as opposed to edges formed by cutting and sewing together layers. That is, a cut-and-sewn edge may comprise one layer folding over the other layers, or a further, separate layer folded over the outer edge of all existing layers, i.e., extending outside the outer shell **52** and inside the inner shell **54**, thus adding one or two further layers at the outer edge, and the folded over portion is sewn to couple together the layers. While bonded edges can provide less bulk (due to less layers) and minimize chaffing compared to cut-and-sewn edges, bonded edges can also provide enhanced strength, for example, at least along the neck opening **58**, to help limit breast movement.

[0054] By way of example, referring to FIGS. **7A** and **7B**, a study was conducted of a wearer (size **34D**) wearing the athletic bra **10** of some embodiments with a bonded neck opening **58**, an athletic bra with a cut-and-sewn neck opening using an additional elastic layer, and an existing athletic bra providing a control bra, while running at 7 km/hr and 10 km/hr. FIG. **7A** illustrates resulting 2D metrics measured from the bonded edge bra **10** (line **144**), the cut-and-sewn edge bra (line **146**), and the control bra (line **148**). As shown in FIG. **7A**, at 7 km/hr, the wearer experienced a 115.5% displacement with the bonded edge bra, a 115.4% displacement with the cut-and-sewn edge bra, and a 123.2% displacement with the control bra. At 10 km/hr, the wearer experienced a 118.3% displacement with the bonded edge bra, a 121.4% displacement with the cut-and-sewn edge bra, and a 132.2% displacement with the control bra.

[0055] Furthermore, FIG. **7B** illustrates resulting 3D metrics measured from the bonded edge bra **10** (line **150**), the cut-and-sewn edge bra (line **152**), and the control bra (line **154**). As shown in FIG. **7B**, at 7 km/hr, the wearer experienced a 13.07 mm displacement with the bonded edge bra, a 14.67 mm displacement with the cut-and-sewn edge bra, and a 20.67 mm displacement with the control bra. At 10 km/hr, the wearer experienced a 16.46 mm displacement with the bonded edge bra, a 19.8 mm displacement with the cut-and-sewn edge bra, and a 26.54 mm displacement with the control bra. As shown in the results of FIGS. **7A** and **7B**, while a cut-and-sewn edge neck opening with elastic may have sufficient strength to help limit breast movement, at least at 7 km/hr running, the present bra with a bonded edge neck opening **58** provides more breast control, i.e., reducing lateral and vertical displacement, at 7 km/hr running and during higher intensity activity such as 10 km/hr running.

[0056] As illustrated above, the cup design, shell fabric, coverage type, and/or seam type of the athletic bra **10** of some embodiments, can positively impact its ability to provide improved breast support for high intensity activities. Notably, such features were shown to improve support without certain uncomfortable additions common to other high-impact athletic bras, such as underwires, rigid cups, or increased compression. However, it should be noted that the athletic bra may incorporate one or more of these features in some embodiments. Furthermore, additional features may be incorporated into the athletic bra **10** of some embodiments to further enhance support and improve comfort. For example, in some embodiments, referring to FIGS. **1** and **2**, the first strap **40** and the second strap **42** can each have a width **W1** configured to support the front panel **38** and avoid digging into the wearer. In some embodiments, for a **34D** size athletic bra **10**, the width **W1** of the straps **40, 42** can be about 3.5 cm. In some embodiments, the width **W1** may be a minimum of 3.5 cm (i.e., 3.5 cm or greater). More generally, in some embodiments, the width **W1** can range from 2 cm to 5 cm, from 2.5 cm to 4.5 cm, or from 3 cm to 4 cm. As another example, in some embodiments, as noted above, the underband **48** can include an elastic band. The underband **48**, or at least the elastic band incorporated into the underband **48**, can have a height **H2** (shown in FIGS. **1** and **2**) configured to support the breasts without digging into the torso **34** or riding up or down the torso **34** during high intensity activities. In some embodiments, for a **34D** size athletic bra **10**,

the height H2 of the underband **48** can be about 3.8 cm, or about 3.5 cm. In some embodiments, the height H2 may be a minimum of 3.5 cm (i.e., 3.5 cm or greater). More generally, in some embodiments, the height H2 can range from 2 cm to 5 cm, from 2.5 cm to 4.5 cm, or from 3 cm to 4 cm. Furthermore, in some embodiments, the underband **48** can include two layers of elastic bands, which can further support the breasts **36** without decreasing comfort.

[0057] Any of the embodiments described herein may be modified to include any of the structures or methodologies disclosed in connection with different embodiments. Further, the present disclosure is not limited to athletic bras of the type specifically shown. Still further, aspects of the athletic bras of any of the embodiments disclosed herein may be modified to work with any type of bra, apparel, or other athletic equipment.

[0058] As noted previously, it will be appreciated by those skilled in the art that while the disclosure has been described above in connection with particular embodiments and examples, the disclosure is not necessarily so limited, and that numerous other embodiments, examples, uses, modifications and departures from the embodiments, examples and uses are intended to be encompassed by the claims attached hereto. The entire disclosure of each patent and publication cited herein is incorporated by reference, as if each such patent or publication were individually incorporated by reference herein. Various features and advantages of the invention are set forth in the following claims.

INDUSTRIAL APPLICABILITY

[0059] Numerous modifications to the present disclosure will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only and is presented for the purpose of enabling those skilled in the art to make and use the invention. The exclusive rights to all modifications which come within the scope of the appended claims are reserved.

Claims

1. An athletic bra, comprising: a front panel, a rear panel, a first strap, and a second strap, the first strap and the second strap connecting the front panel to the rear panel; and an underband coupled to the front panel and the rear panel, wherein the front panel comprises an outer shell and an inner layer, wherein a first cup and a second cup are positioned within the front panel, and wherein at least one of the first cup and the second cup is coupled to at least one of the outer shell and the inner layer, such that the at least one of the first cup and the second cup is not removable.
2. The athletic bra of claim 1 further including side panels that are configured to overlay portions of a side torso of a wearer.
3. The athletic bra of claim 1, wherein the outer shell and the inner layer comprise the same fabric type.
4. The athletic bra of claim 1 further including a rear opening between the rear panel and the underband.
5. The athletic bra of claim 1, wherein the rear panel forms a “T-shape” before joining the first strap and the second strap.
6. The athletic bra of claim 1, wherein the underband discontinuously extends around an entire circumference of the athletic bra.
7. The athletic bra of claim 1, wherein the underband has an adjustable circumference.
8. An athletic bra, comprising: a front panel, a rear panel, a first strap, and a second strap, the first strap and the second strap connecting the front panel to the rear panel, and the front panel including an outer shell and an inner layer; an underband coupled to the front panel and the rear panel; and a first cup and a second cup coupled to the inner layer such that the first cup and the second cup are not removable, wherein the first cup and the second cup include a first layer of a first material and a second layer of a second material, and wherein the first material is a foam material and the second

material is a knitted fabric.

- 9.** The athletic bra of claim 8, wherein the first layer and the second layer are coupled together using a third material, wherein the third material is a polyurethane hot melt.
 - 10.** The athletic bra of claim 8, wherein the foam material is a polyurethane foam material.
 - 11.** The athletic bra of claim 8, wherein the outer shell is made of a fabric comprising polyamide and spandex.
 - 12.** The athletic bra of claim 8, wherein the outer shell and inner layer are bonded together at an outer edge.
 - 13.** An athletic bra, comprising: a front panel, a rear panel, a first strap, and a second strap, the first strap and the second strap connecting the front panel to the rear panel; an underband coupled to the front panel and the rear panel; and a rear opening disposed on the rear panel, wherein the first strap and the second strap are an adjustable length by including adjustment slides, wherein the underband is an adjustable circumference by incorporating a plurality of sets of eyes at different locations distanced from an edge of an end of the underband, and wherein the end of the underband is adjacent to the rear opening.
 - 14.** The athletic bra of claim 13 further including a first cup and a second cup that are directly coupled to the front panel, such that the first cup and the second cup are not removable.
 - 15.** The athletic bra of claim 14, wherein the first cup and the second cup include a first layer and a second layer that are attached using an adhesive.
 - 16.** The athletic bra of claim 15, wherein the first layer comprises a foam material, wherein the second layer comprises a knit fabric, and wherein the adhesive is a polyurethane hot melt.
 - 17.** The athletic bra of claim 13, wherein the front panel includes an outer shell and an inner layer, and wherein the outer shell comprises between 60% and 65% polyamide and between 35% and 40% spandex.
 - 18.** The athletic bra of claim 17, wherein an edge of the outer shell is bonded to an edge of the inner layer to define a neck opening.
 - 19.** The athletic bra of claim 18 further including a first cup and a second cup, wherein the first cup and the second cup extend upward to a top end that is adjacent but spaced apart from the neck opening.
 - 20.** The athletic bra of claim 13 further including a first cup, wherein the first cup has an outer perimeter that extends from the underband adjacent a central axis of the athletic bra vertically upward, then curves until reaching a top end, then follows a curve of a side opening of the athletic bra, then extends straight vertically downward back toward the underband.
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