[0004] Standards have been promulgated that govern the performance of such garments (or constituent layers or parts of such garments) to ensure that the garments sufficiently protect the wearer in hazardous situations. There is a need for a fabric with improved durability that still complies with all requisite thermal protective properties.

SUMMARY

[0005] The terms "invention," "the invention," "this invention" and "the present invention" used in this patent are intended to refer broadly to all of the subject matter of this patent and the patent claims below. Statements containing these terms should not be understood to limit the subject matter described herein or to limit the meaning or scope of the patent claims below. Embodiments of the invention covered by this patent are defined by the claims below, not this summary. This summary is a high-level overview of various aspects of the invention and introduces some of the concepts that are further described in the Detailed Description section below. This summary is not intended to identify key or essential features of the claimed subject matter, nor is it intended to be used in isolation to determine the scope of the claimed subject matter. The subject matter should be understood by reference to the entire specification of this patent, all drawings and each claim.

[0006] Embodiments of the present invention relate to flame resistant fabrics formed with fiber blends that provide the requisite flame and thermal protection but that have improved durability. In some embodiments this is accomplished with the use of fiber blends that include relatively large percentages of flame resistant ("FR") nylon fibers.

[0006a] According to a first aspect of the present invention, there is provided a flame resistant fabric formed by first yarns and a second yarns and having a fabric fiber blend, wherein the fabric has a first side and a second side opposite the first side and wherein:

i. the first yarns include a first yarn fiber blend including approximately 5-20 wt.% aramid fibers, 5-20 wt.% modacrylic fibers, 30-50 wt.% cellulosic fibers, and 30-50 wt.% FR nylon fibers;
ii. the second yarns include a second yarn fiber blend including 5-20 wt.% aramid fibers, 5-20 wt.% cellulosic fibers, 30-50 wt.% modacrylic fibers, and 30-50 wt.% FR nylon fibers;
iii. the first yarns are predominantly exposed on the first side of the fabric;
iv. the second yarns are predominantly exposed on the second side of the fabric;

v. the fabric has a char length of 6 inches or less and an afterflame of 2 seconds or less when tested pursuant to ASTM D6413 (2015); and

vi. the fabric has a fabric weight that is between 5 to 9 ounces per square yard, inclusive.

[0006b] According to a second aspect of the present invention, there is provided a garment formed with the above fabric and having a face side and a body side, wherein the first side of the fabric is exposed on the face side of the garment and the second side of the fabric is exposed on the body side of the garment.

[0006c] According to a third aspect of the present invention, there is provided a flame resistant fabric formed by first yarns and a second yarns and having a fabric fiber blend, wherein the fabric has a first side and a second side opposite the first side and wherein:

i. the first yarns include a first yarn fiber blend;

ii. the second yarns include a second yarn fiber blend that is different from the first yarn fiber blend;

iii. the fabric fiber blend includes cellulosic fibers, aramid fibers, modacrylic fibers, and 30-50 wt.% FR nylon fibers;

iv. the first yarns are predominantly exposed on the first side of the fabric;

v. the second yarns are predominantly exposed on the second side of the fabric;

vi. the fabric has a char length of 6 inches or less and an afterflame of 2 seconds or less when tested pursuant to ASTM D6413 (2015);

vii. the fabric has a fabric weight between 5 to 7 ounces per square yard, inclusive;

viii. the fabric has a break strength of at least 150 pounds force in a warp direction of the fabric and of at least 100 pounds force in a fill direction of the fabric;

ix. the fabric has a tear strength of at least 8 pounds force in at least one of the warp direction or fill direction of the fabric; and

x. the fabric achieves a predicted burn injury percentage of 30% or less after 4 seconds, when tested pursuant to ASTM F1930 (2018).

[0006d] According to a fourth aspect of the present invention, there is provided a flame resistant fabric including a fabric fiber blend and formed of a plurality of yarns, wherein:

i. each of the plurality of yarns is formed from a yarn fiber blend that includes aramid fibers, modacrylic fibers, cellulosic fibers, and FR nylon fibers;

ii. the fabric fiber blend includes 5-20 wt. % aramid fibers, 15-40 wt. % modacrylic fibers, 15-40 wt. % cellulosic fibers, and 30-50 wt. % FR nylon fibers, inclusive; and

iii. the fabric has a char length of 6 inches or less and an afterflame of 2 seconds or less when tested pursuant to ASTM D6413 (2015).

[0006e] According to a fifth aspect of the present invention, there is provided a flame resistant fabric including a fabric fiber blend and formed of a plurality of yarns, wherein:

i. each of the plurality of yarns is formed from a yarn fiber blend that includes aramid fibers, modacrylic fibers, cellulosic fibers, and FR nylon fibers;
ii. the fabric fiber blend includes 5-20 wt. % aramid fibers, 15-40 wt. % modacrylic fibers, 15-40 wt. % cellulosic fibers, and 30-50 wt. % FR nylon fibers, inclusive;
iii. the wt. % of FR nylon fibers in the fabric fiber blend is greater than the wt. % of each of the aramid, modacrylic, and cellulosic fibers in the fabric fiber blend;
iv. the fabric has a char length of 6 inches or less and an afterflame of 2 seconds or less when tested pursuant to ASTM D6413 (2015);
v. the fabric has a tear strength of at least 8 pounds force in at least one of the warp direction or fill direction of the fabric; and
vi. the fabric achieves a predicted burn injury percentage of 30% or less after 4 seconds, when tested pursuant to ASTM F1930 (2018).

DETAILED DESCRIPTION

[0007] The subject matter of embodiments of the present invention is described here with specificity to meet statutory requirements, but this description is not necessarily intended to limit the scope of the claims. The claimed subject matter may be embodied in other ways, may include different elements or steps, and may be used in conjunction with other existing or future technologies. This description should not