Creating Barriers – Repellent Finishing for Medical & Protective Apparel

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The healthcare industry is critically dependent on the effectiveness of barrier materials to protect people from toxins, infection, and disease. These barrier materials are an important line of defense and must meet the demands of the environments where they are used. That is why it is so important for healthcare workers to choose the barrier material that will offer them the level of protection that they need. To classify the barrier effectiveness, The Association for the Advancement of Medical Instrumentation, AAMI, has introduced a new standard for barrier protection, PB70:2003 Liquid Barrier Performance and Classification of Protective Apparel and Drapes Intended for Use in Health Care Facilities. This new standard now requires manufacturers to label their materials based on the level of fluid repellency the material offers, which is determined by four industry accepted tests. As the primary suppliers of barrier materials to the healthcare industry, nonwoven manufacturers need to fully understand the labeling system and the tests associated with the new standard to produce products that will meet these standards. Also, manufacturers can use repellent finishes to produce barrier materials with improved barrier performance properties so they can achieve a higher classification level and offer increased protection to our healthcare workers. Repellent finishes represent one of the most effective ways to produce these enhanced barrier materials.

The new AAMI standard, PB70:2003, consists of four classification levels ranging from level one, which is the lowest level of protection, to level four, which is the highest level. Using these classification levels, manufacturers are able to label their products according to the level of protection their product provides. Also, healthcare workers are able to easily identify the level of protection that the product provides, so they may choose the appropriate barrier they need for their procedure. This standard covers all surgical gowns and other protective apparel, as well as drapes and drape accessories.

The first classification level is determined by using AATCC 42 – Water Impact Penetration. This test measures the material's resistance to water penetration under single spray contact. The material is placed on top of a piece of pre-weighed blotter paper and positioned at a 45 degree angle. Then 500 mL of water is sprayed onto the material from a funnel located at a specified distance above the sample. The material is then removed and the blotter paper is weighed to determine the amount of water that has been absorbed. A lower number represents a material more resistant to penetration by water. For a level one classification, a material must pass water impact penetration with a result lower than 4.5 grams. Any material with a result higher than 4.5 grams is considered to be non-protective.

For a level two classification, the material must pass water impact penetration with a result less than 1.0 gram. In addition, the material must be tested using AATCC 127 – Hydrostatic Head Test, which measures the material's resistance to water penetration under increasing pressure. The water or hydrostatic pressure is steadily increased until three water droplets are observed on the sample. At this point, the test is terminated and the hydrostatic pressure is recorded in

centimeters. The higher the hydrostatic pressure, the more resistant the material is to penetration by water. For a level two classification, the material must have a result higher than 20 cm on the hydrostatic head test.

To classify a material in the level three classification, the material is tested using the same two tests that are used for level two classification, water impact penetration and hydrostatic head. Level three materials, which are considered to have good fluid barrier protection, must have a result of less than 1.0 gram on the water impact test and greater than 50 cm on the hydrostatic head test.

Level four materials are considered to be an impervious barrier. In order to be classified as level four, a material must pass both the blood barrier test, ASTM F1670, and the viral barrier test, ASTM F1671. The blood barrier test measures a material's resistance to synthetic blood under constant contact. The sample is mounted on a cell between the synthetic blood and a viewing port. It is then subjected to atmospheric pressure for 5 minutes, 2.0 psi for 1 minute and atmospheric pressure for 54 minutes. If any synthetic blood comes through the sample during these sixty minutes, the sample fails the test. The viral barrier test measures the material's resistance to penetration of a microorganism under constant contact. Like the blood barrier test, the sample is mounted on a cell separating the microbial challenge and a viewing port. It is then subjected to the same time and pressure protocol. If any liquid penetration occurs during this time, the sample fails and the test is terminated. If there is no visible liquid penetration at the end of the sixty minutes, a very sensitive microbial assay is performed to determine if any non-visible penetration occurred. If any microbial penetration is found, the sample fails the test.

Table 1 – AAMI Classification Levels

Level	Test	Result
1	AATCC 42	≤ 4.5 g
2	AATCC 42 AATCC 127	≤ 1.0 g ≥ 20 cm
3	AATCC 42 AATCC 127	≤ 1.0 g ≥ 50 cm
4	ASTM F1670 ASTM F1671	Pass Pass

According to the AAMI standard, all materials for use in surgical gowns and drapes must be classified using this system. Nonwoven materials, which are often termed single-use materials in the healthcare industry, are excellent materials for this end use. The three most commonly used nonwovens for this application are spunlace, spunbond/meltblown/spunbond (SMS), and wetlaids. Spunlace nonwovens are formed by entangling fibers using high-velocity water jets. For surgical gowns and drapes, the most commonly used materials are a blend of wood pulp and polyester fibers. The SMS nonwoven is a fabric consisting of layers of spunbonded materials and meltblown materials. The spunbond is made up of continuous, molten filaments which are formed by in-line melt spinning. The meltblown fibers are similar to the spunbond in how they are formed, but they are much finer and not continuous. These layers are then thermally or

adhesively bonded together to form the SMS nonwoven. Polypropylene is the most commonly used polymer in SMS nonwovens for gowns and drapes, but polyethylene may also be used. The third nonwoven, a wetlaid, is formed by suspending fibers in water in a uniform dispersion and then separating them from the slurry by draining the water through a fine mesh screen. Wood pulp and polyester are the most commonly used fibers for this application and often require the use of a chemical binder to help bond the fibers together.

Most of these nonwovens are made from synthetic materials, which are hydrophobic and naturally repellent, but they still may need some chemical assistance to improve their level of repellency. Fluorochemicals, waxes, and even foam finishes can enhance the barrier properties of these materials and help nonwoven manufacturers produce products with a higher classification level.

Fluorochemicals can be applied to all three of the nonwoven substrates that were discussed. They enhance repellency by the way they orient themselves on the fabric. The fluorine molecules form a continuous film on the surface of the fabric thereby lowering the surface energy and giving the fabric its repellency properties. A wood pulp/polyester spunlace or a SMS treated with a fluorochemical makes an excellent surgical gown material because it not only repels water but also repels alcohol.

Waxes are most commonly used on woodpulp/polyester spunlaces. They enhance the repellency properties as well as make the fabric much softer by forming a layer on the surface of the fabric that repels the water and gives the fabric a soft, slick hand. These materials are often used in single use surgical gowns because they are cheap and effective, but they are not durable and may be easily abraded.

Foam finishes can be applied so that they form a barrier layer on the fabric through which liquid cannot penetrate. They are most often used for surgical drape applications. The foam finish consists of a binder to give the foam stability and to serve as a filling agent. Also, it incorporates a surfactant to aid in foaming and most likely a fluorochemical to give it added repellency properties. Foam finishes can be applied to most any nonwoven substrate because the chemistry sets on top and does not have to be absorbed by the substrate. However, the substrate should be strong enough and have enough substance or basis weight to support the foam layer, especially during the application process.

Healthcare workers depend on their garments for protection. Repellent finishes, such as fluorochemicals, waxes, and foam finishes, can be the key ingredient to improving the barrier properties of a nonwoven material and offering the healthcare worker a higher degree of protection and safety. These workers expose themselves to many different toxins in various forms, which is why it is so important for them to choose the right level of protection. The new AAMI standard enables them to make the best choice. For healthcare workers, this label can mean the difference in exposure to harmful toxins or containing risk.

References:

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Creating Barriers

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Precision Fabrics Group, Inc.

PB70:2003

- New AAMI standard
- Classifies barrier protection
- Requires manufacturers to label their products
- Helps users understand the level of protection
- Four levels

PB70:2003

Level 1

- AATCC 42 – Water impact penetration test
  - Must be < 4.5 grams

PB70:2003

Level 2

- AATCC 42 – Water impact penetration test
  - Must be < 1.0 gram
- AATCC 127 – Hydrostatic Head test
  - Must be > 20 cm

PB70:2003

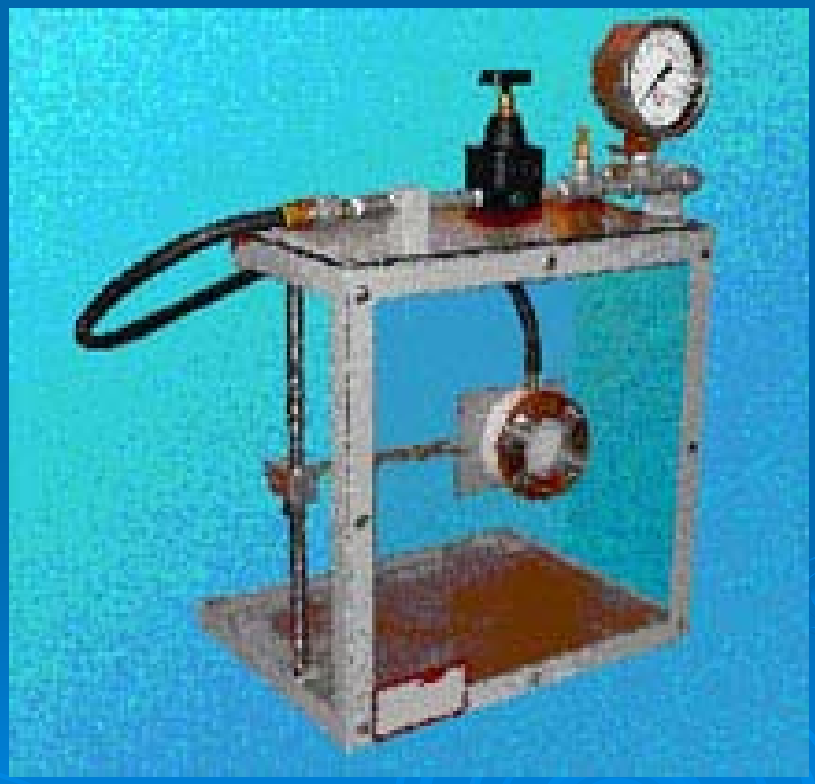
Level 3

- AATCC 42 – Water impact penetration test
  - Must be < 1.0 gram
- AATCC 127 – Hydrostatic Head test
  - Must be > 50 cm

PB70:2003

Level 4

- ASTM F1671 – Viral barrier
- ASTM F1670 – Blood barrier



PB70:2003

Level	Test	Result
1	Water Impact	≤ 4.5 g
2	Water Impact Hydro Head	≤ 1.0 g ≥ 20 cm
3	Water Impact Hydro Head	≤ 1.0 g ≥ 50 cm
4	Viral Barrier Blood Barrier	Pass Pass

Nonwovens

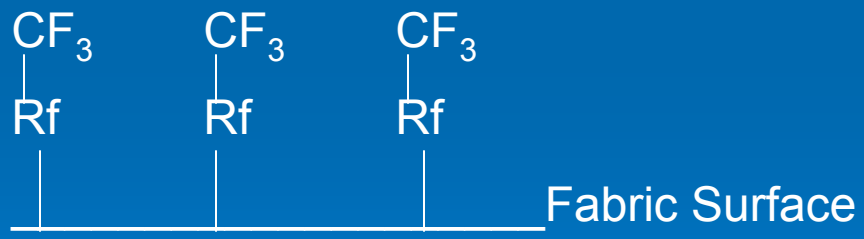
- Spunlace
  - Woodpulp / Polyester
- Spunbond/Meltblown/Spunbond (SMS)
  - Polypropylene
  - Polyethylene
- Wetlaid
  - Woodpulp / Polyester

Repellent Finishes

- Fluorochemicals
- Waxes
- Foam finishes

Fluorochemicals

- Repel water and alcohol
- Form a continuous film
- Lower surface energy
- Expensive



Waxes

- Repel water
- Give fabric a soft, slick hand
- Cheap
- Non-durable
- Easily abraded
- May be used as extenders

Foam finishes

- Form a barrier layer
- Can be applied to any substrate
- Most often used for surgical drapes

Conclusion

- Repellent finishes
  - Improve barrier properties
  - Offer a higher level of protection
  - May help nonwoven manufacturers achieve a higher AAMI classification