

## FAQs About Zylon® Materials in Body Armor

**1. What is Zylon®?**

Zylon® is a synthetic fiber developed by a company called Toyobo. Zylon® fiber has high tensile strength and thermal stability and flame resistance when compared to organic fibers. Zylon® is used in sporting goods; protective gear such as gloves and ballistic vests; and flame retardant suits, sailcloth, racing suits, high tension rope and cable and aerospace components.

**2. Why is Zylon® fiber used as a ballistic material?**

Because of its unique physical properties, Zylon® fiber-based materials provide ballistic protection at a low areal density or weight. With the increasing consumer desire for higher performance yet also improved comfort, vest manufacturers and end-users alike have embraced the benefits of Zylon® fiber based ballistic materials.

**3. How is Zylon® fiber turned into a ballistic material?**

Toyobo of Japan, the manufacturer of Zylon® fiber, only sells Zylon® as spools of continuous filament yarn. Zylon® yarn is offered in many different thicknesses (deniers) and is sold to two main types of converters. These companies either weave the fiber into a fabric, or use special processes to lay it up in resins to form thin, flexible nonwoven composite materials.

Weavers convert Zylon® yarn into a myriad of different styles of ballistic fabric. By using or combining different deniers or fibers into particular fabric constructions, a multitude of fabric designs can be achieved. These unique and often proprietary weaves provide a number of Zylon®-based fabric solutions a vest manufacturer can employ to stop a specific type of round.

Certain vest models may also employ a proprietary lamination process, bonding two or more layers of fabric together, creating yet another Zylon®-based fabric. ZShield™ is one such special flexible composite Zylon®-based material. It is sold exclusively to Armor Holdings Products Division by Honeywell's High Performance Fiber Group. ZShield™ is created from a patented process that combines layers of Zylon® fiber with a special resin, sandwiched between two layers of a protective film. The result of this combination is a very thin, yet strong, nonwoven composite ballistic material.

**4. Where can I find out more information about Zylon® fiber?**

Visit the fibers website at Toyobo at [www.toyobo.co.jp/e/seihin](http://www.toyobo.co.jp/e/seihin). Honeywell also offers reference materials at [www.performancefibers.com](http://www.performancefibers.com).

**5. What other materials are used in making ballistic vests?**

Ballistic materials such as Kevlar® and Twaron, which are aramid fibers with a high-energy absorption, high tenacity strength, are used in many different weaves. They are also used in a nonwoven form commonly called Gold-Flex™ ballistic material. Spectra® fiber, an ultra-high molecular weight polyethylene also is used in many different weaves, but is commonly used in nonwoven forms called SpectraShield® LCR, SpectraFlex®, and Spectra Shield® Plus Flex materials. Woven blends of some of the different fibers discussed above are beginning to be used.

- 6. What are the mechanical properties you assess when evaluating ballistic fibers?**  
You want a good combination of the following: tensile strength, tensile modulus, elongation, density, moisture retention, impact energy absorption, heat resistance and limiting oxygen index. We evaluate these properties within a layer of fabric for weight and flexibility.
- 7. How many different materials do you use in your vests?**  
We have dozens of different ballistic fabrics in stock that we use for our vest constructions.
- 8. Who supplies your ballistic materials?**  
Honeywell, DuPont, Toyobo, Hexcel, and Barrday are some of our major material suppliers.
- 9. Are all body armor vests made the same way?**  
No. Manufacturers choose the particular ballistic materials they want to use based upon performance and price. Also the manufacturing process, type of thread and stitch patterns employed and ballistic cover seal used may also be different. The end result is to ensure the ballistic performance conforms to the NIJ rules. At American Body Armor, PROTECH™ and Safariland® we use our own proprietary research and design engineering to determine the right ballistic material, in the right spot, for the right function.
- 10. What do you mean by the right material, right spot and right function?**  
Each material has inherent strengths and weaknesses dependant upon the threat and target specification you need to achieve. Each layer of ballistic fabric is purposefully and sequentially ordered to maximize the targeted results. The completed “ballistic package” is engineered to match the threat, whether it be ballistic, stab, trauma or any combination.
- 11. How do you “engineer” your ABA, PROTECH™ and Safariland® vests?**  
We select the best combination of ballistic materials to meet the threat required to be matched. Our vests are engineered as a hybrid construction. A hybrid construction is one in which several different ballistic materials are chosen for their particular talents or ballistic performance. Then we layer each fabric in a specific order from the strike face of the vest to the back. These combined layers then work together as a team to maximize the performance of that “ballistic package.” Throughout this process we test and retest to ensure the performance of the ballistic package not only meets our own quality standards but the NIJ criteria as well.
- 12. Can ballistic materials degrade in use?**  
Yes. It is an industry recognized fact that the various mechanical properties in ballistic materials can, over time, degenerate from their initial performance starting point. Ballistic material suppliers such as Honeywell, DuPont, Toyobo, etc., aggressively test their ballistic materials in extreme heat, cold, and humidity. In addition, the amount of wear and tear from usage affects material degradation. That is why the five-year, normal wear cycle vest warranty was established. We anticipate this in our vest designs and provide clear care and use guidelines within the owner’s manual for each vest we make.

- 13. Is there a report showing Zylon® FIBER degrading when exposed to a combination high heat and humidity simultaneously?**  
Yes, however it is important to understand the testing and results as they apply to a vest worn on an officer. Toyobo has routinely published an ongoing report showing both uncontrolled warehouse and high combined heat and humidity data from in-house testing of the as-produced fiber. The high heat and humidity condition is generated artificially in a special chamber. In the reported data, only the tenacity of the fiber is cited. As mentioned earlier, tenacity is only one of the many properties which contribute to the ballistic response of a material.
- 14. What are the warehouse testing conditions?**  
Toyobo's warehouse in Tsumga, Japan registers an annual temperature range from 26.6° F to a maximum of 98.3° F at an average 70% humidity. Data shows a two to three percent loss in the mechanical property of "tenacity" in the raw yarn just after the first few days of storage. Toyobo concludes this is part of the curing process of the Zylon® yarn. After the initial reduction in tenacity, a very slight reduction over time may be observed.
- 15. What do those results mean for the Zylon® yarn shipped to the U.S. for weaving?**  
From the data Toyobo has published it appears that the greatest change in tenacity has occurred by the time we have received the material and hence is already incorporated into our vest design.
- 16. When you subject a vest containing Zylon® fabric to testing and also submit it for NIJ certification, is the initial tenacity depletion in the raw yarn during curing really a factor?**  
No. We have already engineered the vest with the various fabric layers so our own testing and also the results with certification verifies the performance design of that ballistic package.
- 17. What are the conditions of the as-produced Zylon® yarn tested in Toyobo's heat and humidity chamber?**  
Toyobo has placed as-produced Zylon® fiber in a chamber that is set to 104°F and 80% relative humidity, 24/7, 365 days of the year. The emphasis is on the word "and" because they are intentionally stressing the raw yarn.
- 18. Why is this type of testing used?**  
This type of testing is used as an attempt at "accelerated aging" but although extreme conditions are used to simulate aging, it does not always directly correlate and in fact can generate conditions that would never occur in a material. For example, if you were to take some of the materials used in clothing and iron them at too high a heat setting (extreme condition) and they shriveled and scorched, this would NOT be simulating aging of the material as it could last years if PROPERLY cared for. Similarly, excessive heat in a clothes dryer can shrink clothes or ruin elastic.
- 19. How do those specific conditions of combined heat and humidity relate to our climate in the U.S.?**  
It is not realistic. From NASA— "Typically on the planet the highest temperatures occur in those places where the soil is dry and the atmosphere contains little water-desert areas...the drier the soil the less the evaporation, and thus, the higher the maximum temperature and the lower the humidity." From a National Weather Service meteorologist: "These conditions are so rare on our planet that the possible chance of it occurring might be in Calcutta, India, in July in monsoon season."

**20. Why did Toyobo choose those extreme conditions?**

They chose that artificial environment in an attempt to simulate advanced aging of the fibers to determine if a ballistic vest would be able to last 10 years when being worn by an officer. During extreme heat and humidity conditions a process called “hydrolysis” may occur. Hydrolysis is a chemical reaction in which water reacts with a compound to produce other compounds.

**21. I store my ballistic vest containing Zylon® in the trunk of my car when not in use. Is this a problem?**

Your ballistic vest is a high performance tool, just like your weapon and your duty gear. It should be given the same care as these other tools. In order to maintain and protect its optimal ballistic performance, your ballistic vest should be stored at normal room temperature in a dry place. When not in use, avoid storing your ballistic vest in places where it is exposed to persistent high temperatures (120°F and above) in combination with high humidity (50% and above) for long uninterrupted periods of time (two weeks or more). Ordinary daily temperature and humidity conditions experienced while wearing your vest during routine shifts will not have an adverse affect on the performance of your ballistic vest. For additional information see the care and use section of your owner’s manual.

**22. Is there an industry standard test that simulates ballistic fiber aging over ten years?** There is no test universally agreed upon that can simulate 10 years of aging. Raw material manufacturers conduct their own proprietary testing and use field testing and ballistic retesting of their materials when put into fabrics and built into vest designs.

**23. How does this apply to the Zylon® in my vest?**

First, there is no raw Zylon® fiber in your vest. It has been twisted into a yarn which has been woven and layered into a quilt-like pattern and could even be laminated. Weaving by itself does not directly change anything around the inherent fiber. Twisting of the fiber can increase the tenacity of the fiber. However, the waterproofing, sizing, resin and lamination can and do make changes and improvements to the fiber.

Second, there are many layers incorporated into your vest in what we call a hybrid construction which serves to work together with other ballistic layers to maximize performance.

Third, your AHPD ballistic package is covered with a polyolefin cover that is either heat sealed or waterproofed. This cover protects the ballistic package from the outside elements, like moisture, the sun and UV.

Finally, the high temperature and high relative humidity used in Toyobo’s tests is a climatic condition that is not naturally found on earth.

**24. Do you intend to stop using Zylon®?**

No. Our quality assurance programs and hybrid construction technology builds upon the strength of Zylon® materials. Zylon® continues to offer a performance advantage.

**25. Is AHPD performing any testing around the Zylon® issue?**

Testing is an integral part of our design and development process and continues to be important even after the body armor from any of our brands is placed into service. We have also periodically tested body armor from the field. This will be continued across all body armor brands and configurations.

Our testing of body armor does not indicate performance issues. We will continue to conduct testing for product performance.

**26. I've seen reports that say that Zylon® fails under heat and humidity. I've got a vest with Zylon® and I'm worried!**

To date the tests we have conducted of Zylon® based vests show no unanticipated degradation in ballistic performance. Further, the tests of Zylon® fiber that have been conducted by the manufacturer Toyobo and shared with the industry do not appear to support the conclusion with respect to fiber exposed to normal, everyday conditions.

**27. When it is 110° outside and I'm sweating, should I be concerned about degradation to my Zylon® vest?**

Body armor manufactured by American Body Armor, PROTECH™ and Safariland® features a ballistic panel enclosed in a water resistant shell to protect it from such conditions. Environmental testing conditions simulated in our labs have proven that our hybrid vest meets or exceeds performance expectations in conditions much more severe than the one indicated above.

**28. An officer in my region says he has a test report from Toyobo stating that Zylon® has a shrinkage issue in high temperatures. He is concerned because he stores his tactical vest in his trunk.**

Toyobo consistently supplies us with all test reports regarding their fibers. There is no such report on shrinkage of Zylon®. The importance of vest storage cannot be overstressed. This type of improper storage can affect all ballistic fibers regardless of the fiber or vest manufacturer. We encourage you to review the owner's manual provided with each vest.

**29. Is Armor Holdings Products Division going to recall vests?**

No.

**30. There is a rumor going around that the US military is pulling all of its Zylon® vests.**

Most US military organizations are required to buy and use only American made products. Although woven in the United States, the Zylon® fiber is currently made in Japan, limiting its broad use within the US military. The Department of Defense has a significant test and evaluation history of many ballistic materials and readily advises military users on the performance and expectations of these materials prior to, and during body armor procurements. Examination of any Zylon®-based armor is at the discretion of the Department of Defense; however we are unaware of a broad-based withdrawal of Zylon®-based armor.

**31. Does AHPD make vests that do not contain Zylon®?**

Absolutely. We have many models to choose from based upon level of protection desired and officer's preferred comfort needs.

**32. How should I determine which vest is right for me?**

First, make sure that the threat level of the vest you choose stops the ammunition that you carry in your own weapon, that of neighboring departments as well as the threats you are confiscating on the streets. Be sure the vest is NIJ-approved and from a reputable manufacturer.

You'll also want to consider how you will be wearing it – every day or only as needed – and where you will have to store the vest. Vest used infrequently would need to be properly stored in room temperature conditions to maintain performance. Other factors such as weight, thinness, flexibility and cost factors are completely up to the department and/or the individual officer.

**33. Where can I find out more information about threat level specifications?**

Contact the National Law Enforcement and Corrections Technology Center

P.O. Box 1160

Rockville, MD 20849 – 1160

[asknlectc.org](http://asknlectc.org)

[www.nlectc.org](http://www.nlectc.org)

For more information about the environmental effects on personal body armor, visit [www.nlectc.org/testing/ba\\_environment.html](http://www.nlectc.org/testing/ba_environment.html)