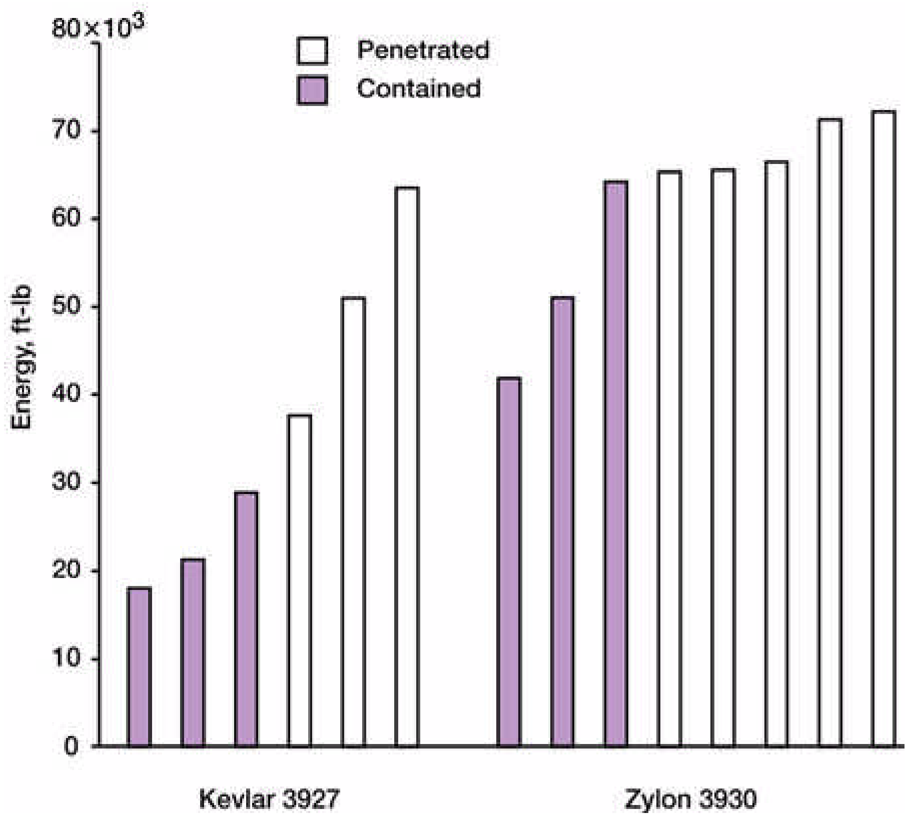
Excellent Ballistic Impact Properties Demonstrated By New Fabric

Recently, a relatively new industrial fiber known by the trade name Zylon has been under commercial development by Toyobo Co., Ltd., Japan. In ballistic impact tests conducted at the NASA Glenn Research Center, it was found that dry fabric braided of Zylon had greater ballistic impact capacity than comparable (braid style and weight) fabric braided of Kevlar (DuPont Corp., Wilmington, DE).

To study the potential use of Zylon fabric in jet engine containment systems, the fabric was tested in Glenn's Structures and Acoustics Division Ballistic Impact Facility under conditions simulating those which occur in a jet engine blade-out event. Circular ring test specimens were fabricated by wrapping five layers of braided Zylon or Kevlar fabric around an inner ring made of a thin sheet of aluminum and a 1-in.-thick layer of aluminum honeycomb. The test specimens had an inner diameter of 40 in., an axial length of 10 in., and a wall thickness of approximately 1.5in. A test specimen is shown in the photograph.

Test specimen mounted on a fixture in front of the impact gun. The specimen is supported at a slight incline so that the projectile can impact it from the inside.

The test specimens were mounted on a table in front of a 40-ft-long, 8-in.-diameter gas gun such that the specimen was at a slight incline from horizontal. Titanium disks that were 4.5 in. in diameter, 0.75 in. thick, and weighed approximately 1.9 lb were shot out of the gas gun into the specimens at speeds up to 1600 ft/sec. The orientation of the test specimen allowed the projectile to impact the inside of the ring, similar to a fan blade fragment impacting the inside of a fan case. The impact tests were conducted in such a way that some of the projectiles penetrated the specimen, and some were contained (did not penetrate). Knowing the speed and mass of the projectile, we were able to determine the amount of kinetic energy that the rings could absorb before penetration occurred (sometimes referred to as the ballistic limit or ballistic threshold).



Results of impact tests on Kevlar and Zylon. Each vertical bar represents a single impact test, with the vertical axis showing the kinetic energy of the projectile.

Long description Bar graph showing the impact velocity of a number of impact tests. The height of the bar represents the impact velocity in a particular test. Some of the bars in the graph are shaded and some are not. The ones that are shaded represent tests in which the projectile did not penetrate the specimens. These tests were conducted at lower impact speeds than those where the projectile penetrated and passed through the specimen (which are represented by the unshaded bars). The speed required to penetrate the specimen lies between the speed associated with the highest shaded bar and that associated with the lowest unshaded bar. The figure demonstrates that this penetration speed for Zylon material is approximately twice as much as that for Kevlar.

The impact test results (see the preceding bar chart) showed that rings incorporating braided Zylon fabric could absorb approximately twice as much kinetic energy as rings using Kevlar fabric of comparable weight and braid style. Each bar represents a single impact test, with the vertical axis showing the kinetic energy of the projectile. The shaded bars represent tests in which the projectile was contained (did not penetrate the specimen), whereas the open bars represent tests in which the projectile penetrated the specimen. The results indicate that the Kevlar specimens could absorb between 29,000 and 38,000 ft-lb of kinetic energy before penetration. The Zylon specimens could absorb between 64,000 and 65,000 ft-lb of energy, or approximately twice the energy that the Kevlar specimens could absorb.

Find out more about this research http://ballistics.grc.nasa.gov/.

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