

# ACTIVE PROTECTION SYSTEM

*A “smart” impact protection textile with superior defense and comfort has won the 2008 ASM International Engineering Materials Achievement Award for Dow Corning Corp.*

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**T**he Dow Corning Active Protection System is a unique “smart” technical textile. It is an alternative to hard, rigid armor systems for protection against high-energy impacts. The system is comprised of innovative materials that instantly become rigid upon impact, but flex with body movements when protection is not required.

Because the system is a textile, it can easily be integrated into protective garments by traditional cutting and sewing techniques. It can be built up in layers to maximize protection where needed, without compromising design or appearance.

Working with Rukka, a leading innovator of motorcycle apparel and accessories, Active Protection System S7-002 was developed for motorcycling. Rukka’s designers have totally redesigned their motorcycle suit, launching the SRO Anatomic suit October 2006 at the InterMot Motorcycle & Scooter Fair in Cologne, Germany (Fig. 1).

## System structure

The system consists of a three-dimensional spacer textile impregnated with a soft, malleable, and formable silicone dilatant material with energy absorbing properties, Fig. 2. This unique combination of silicone and spacer fabric offers a flexible and breathable impact protection solution. Under normal conditions, the system remains soft and flexible. However, when stressed by high-impact force, it instantly transforms to a rigid solid. After the force has been dissipated through the fabric, the silicone quickly becomes soft and flexible again. Independent testing shows that the system meets or exceeds many European Standards for impact protection for sports apparel.

The silicone composition consists of polymers that show transient bonding to a crosslinking component. Under normal conditions, the polymers bond to the crosslinker, so the bonds open when subjected to a long-period deformation force. This allows the material to flow. When this force is removed, the bonds easily re-form, returning the silicone to its original, lightly crosslinked, soft-solid state.

However, if the silicone is subjected to a sudden deformation force, the crosslinking bonds do not



Fig. 1 — The Rukka motorcycle suit made of the Active Protection System provides protection with flexibility.

have time to open. The material resists the force and immediately becomes rigid.

The choice of textile also affects overall impact performance and comfort. Spacer fabrics have been shown to be particularly advantageous and can enhance impact performance, flexibility, and comfort.

When impregnating the fabric, it is particularly important to present the silicone so it can readily absorb the impacting force through the spacer yarns in the direction of the force. Careful engineering of the dimensions of the spacer textile ensures this orientation, allowing the silicone to absorb maximum force, yet leaving the fabric completely breathable. The silicone on the fabric surface and the spacer yarns in the immediate strike area first receive the impacting force. These instantly become rigid and transmit energy to adjacent spacer yarns, which also become rigid, thus spreading the impact.

A further key objective for the Active Protection System was to have it capable of being machine washed in domestic washing machines. This was a significant technical challenge, because the silicone chemistry in the technology is ordinarily sensitive to aggressive laundry conditions. However, through selective modification of the polymers, a very significant improvement in wash resistance was achieved.

For example, for the Rukka motorcycle suit, the effect of washing on impact performance is negligible over the expected lifetime of the suit. This is a huge step forward in impact protection technology, as no other material offers this resistance.

### Test results

Independent testing shows that the Active Protection System meets or exceeds EU protection standards for a variety of sports apparel and equipment. In these tests, a weight is dropped vertically onto the test piece and the transmitted force is measured. For example, Fig. 3 shows a typical impact event under EN 1621-1: 1997 test conditions for limb protection in motorcycle apparel. This test, in which transmitted force is plotted over time, compares a typical hard-shell protector with Active Protection System technology.

In this particular impact test, the mean force transmitted cannot exceed 35 kN. Two layers of the Active Protection System yields results substantially within this limit. A more severe impact test is the motorcycle back protector test, EN1621-2:2003, in which the mean force cannot exceed 18 kN. Three layers of the Active Protection System achieves a transmitted force of approximately 14 kN, again well within the threshold.

### Future applications

Potential applications are virtually unlimited in protective sports and work apparel, industrial and geo fabrics, protective medical devices, architecture and construction, and security and civil defense. While Dow Corning envisions an entire range of products tailored to specific application requirements, the initial focus has been on applications that

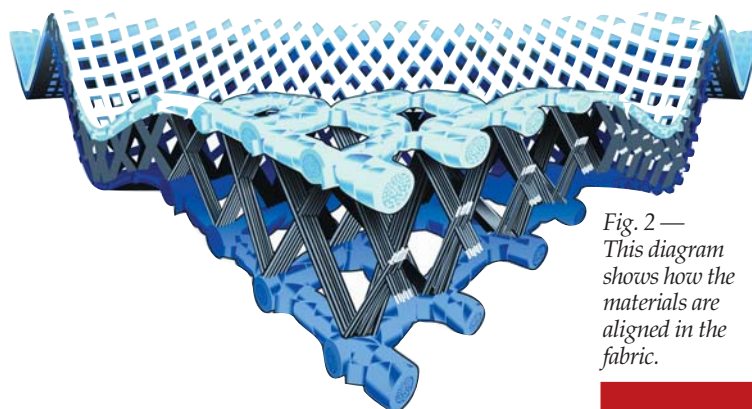
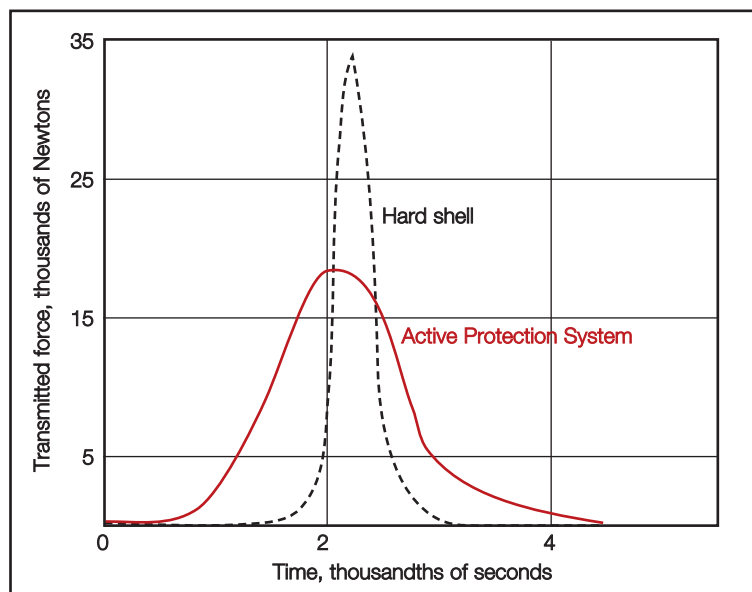


Fig. 2 — This diagram shows how the materials are aligned in the fabric.



The Active Protection System provides better protection than the hard armor system.

require high levels of impact performance and comfort.

In addition to the EN 1621 standards for motorcycle apparel, initial testing of Active Protection System fabric has begun against European Standards minimum safety requirements for a selection of other sports-related protective devices, including:

- Equestrian shoulder protectors
- Martial arts head guards
- Soccer shin guards
- Field hockey shin guards
- Cricket thigh guards
- Cricket batsmen gloves
- Ski helmets

Results show that the protective fabric is capable of passing all the standards when suitably layered to increase thickness. In many cases, the thickness is less than current armor, plus it has the advantage of much improved flexibility and breathability. Testing on motorcycle apparel also shows that the fabric does not lose performance when wet. ●

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