

# Intelligent fabrics protect and improve athletes' performance

## 智能織物保護及提升運動員表現

Prof. Li Yi of the Institute of Textiles and Clothing and his research team have designed and engineered collections of sportswear by integrating multidisciplinary sciences, technologies and arts to meet the biological, physiological and performance requirements of various sporting activities under different environment conditions.

By developing a scientific understanding of the thermal biological, biomechanical and air dynamic characteristics of body motion in various sports, novel body mapping functional design concepts were developed with localized functional mapping for thermal management, biomechanical supporting, air drag reduction and injury prevention (photo 1 & 2).

The designs were realized by applying advanced clothing functional CAD technology, and textile and clothing manufacturing technologies such as dynamic patterning and advanced seamless garment fabrication technologies. The researchers evaluated the functional performance of the design collections by testing the physical properties of fabrics and conducting trials to validate the thermal management, body compression, protection in low limb, fatigue reduction of the main loading muscles and air drag reduction. They also considered aesthetic elements such as colour, form, texture and proportion, integrating them with the functional design, which illustrates the fusion of fashion, art, technology and science.

The design collections were used by Hong Kong elite athletes at the 2008 Beijing Olympics, 2009 East Asian Games, 2011 Asian Rowing Championships and 2012 London Olympics. The group's M\_POWER running wear and S\_POWER cycling wear won the China Successful Design Award in Shanghai in 2011 and the Golden Prize in the 5th Qiaodan Cup International Sport Equipment Design Contest in 2010, respectively. The design innovations have also been

adopted by well-known brands to develop a new generation of high-performance sportswear.

Another researcher, Dr Hu Hong, Associate Professor, has invented a novel kind of intelligent impact protective material that can be used to produce impact protectors for energy absorption and impact spreading. The material can be integrated or inserted into protective garments or equipment for protecting the human body from strokes, blows or falls in impact sports (photo 3 & 4).

The most commonly used impact protectors are made from polyurethane foams and thermoplastics, but are not comfortable due to their low flexibility, air permeability and moisture transmission. However, Dr Hu's intelligent impact protective material is based on 3D warp-knitted spacer fabrics finished with impact hardening polymer. The 3D spacer fabrics are constructed with specially designed hexagonal mesh structure, and the impact hardening polymer is synthesized using silicon-based materials with the addition of nano-particles to enhance its ability to absorb and dissipate energy.

The newly developed 3D auxetic spacer fabrics can transversally expand when stretched, making them fit very well with the body's shape, especially around knees and elbows. In addition, Dr Hu developed a stress-responsive, impact-hardening polymer. This polymer remains soft in normal use but becomes rigid instantly under impact to prevent the concentration of impact force and to maximally absorb and dissipate the impact energy. After impact, the polymer immediately turns flexible again.

The new intelligent impact protectors have a few important advantages. They exhibit high performance in their impact protection and excellent comfort due to high air permeability and flexibility, and are easy to use and care for because they are washable and can be cut into any size and shape.



2. Biomechanical design  
生物力學設計

Researchers at PolyU's Institute of Textiles and Clothing have developed high-performance sportswear and fabrics to enhance the performance of sportspeople and dissipate impact force during sporting activities.

理大紡織及製衣學系的研究人員開發出高性能的運動服和織物，以提升運動員的表現和在運動的過程中消減衝擊力。

紡織及製衣學系李翼教授及其研究團隊研發出一系列高性能運動服，結合不同範疇的科學、科技及藝術美學，以滿足穿著者在不同環境下進行不同體育運動時在生物、生理和性能等多方面的需求。

「S\_POWER」自行車服亦在二零一零年第五屆喬丹杯國際運動裝備設計大賽中奪得金獎。這系列創新設計已被國際知名品牌所採納，日後將用於生產新一代高性能運動服。

另一方面，副教授胡紅博士開發了一種嶄新的「智能防衝材料」。這是一種能量吸收織物，可以用於衝擊防護服或裝備，保護人體在創傷性運動中免受衝擊，打擊或跌倒的傷害（圖3、4）。

現有防衝護具都是由聚氨酯泡沫和熱塑性塑料製成，柔軟性、透氣度和透濕性較低，因而舒適程度亦較低。然而，胡博士開發的「智能防衝材料」是由三維間隔織物和衝擊變硬聚合物複合而成。間隔織物具有三維六邊形網格結構，衝擊變硬聚合物則由有機矽和納米顆粒複合而成，以提高其能量吸收及消散功能。

新開發的三維間隔織物在縱向拉伸下向橫張開，能夠更緊貼人體體形，尤其在膝蓋和手肘部位。此外，胡博士亦開發了智能衝擊變硬聚合物。在未受衝擊時，此聚合物會保持柔性，但當受硬物衝擊時就會即時變硬，避免衝擊力集中，從而盡量吸收及消散衝擊力。衝擊過後，聚合物立即恢復柔性。

這種智能防衝織物具備多項優點，除高防衝防護性外，亦因其高透濕性和柔軟性，所以舒適度很高，並且可洗可裁剪，易於使用和護理。

4. Sportswear made of intelligent impact protective 3D spacer fabrics  
由三維智能防衝間隔織物製成的防衝運動服裝



3. Intelligent Impact Protective 3D Spacer Fabrics  
智能防衝三維間隔織物

