

Composite Sports Equipment: A Vision for the future

Abstract:

New and innovative sports equipment can be developed by introducing lightweight materials in modern day sports industry production lines. The properties of these new materials are expected to result in improved ergonomics, energy savings, increased flexibility and more robust equipment, which in the end will result in enhanced productivity. Composite materials are one such alternative that has excellent material properties. These properties are well documented, and the market for carbon composite materials is growing in many areas such as commercial aircrafts, sporting goods, etc. **Sialkot** is globally known as the producer of quality products in sports goods, surgical instruments, leather garments, gloves and accessories, sportswear and musical instruments. **Sialkot's** Sporting Goods Industry is facing a deteriorating phase, as it fails to equip itself with the emerging demand of Composite Materials. This article would serve to highlight the prospects of ever growing potentials of Composite based sports goods industry and the rising need of its adaptation to boost our sports goods exports.

Introduction:

According to the COMPASS¹ project carried out by European Union sports federations in 2003, the definition of sports is: **“Sports' are all forms of physical activity which, through casual or organized participation, aim at expressing or improving physical fitness and mental well-being, forming social relationships or obtaining results in competition at all levels”**. The first record of manufacturing of sports goods in **Sialkot** can be traced back to 1883 when Sardar Bahadur Singh and Sardar Ganda Singh Oberoi built a factory to produce sports goods for the British Army soldiers stationed in

the northern sub-continent. The products manufactured were wooden, such as cricket bats, hockey sticks, polo sticks, etc. In 1918, a British Army soldier for repairs at Oberoi's factory, where a Muslim artisan known as Syed Sahib was assigned the task, brought a football. Syed Sahib not only re-stitched the football to the full satisfaction of army personal but also “reverse engineered” it in his own small manufacturing unit. British soldiers were astonished to play with the local version and they praised Syed Sahib for his skills.

Subsequently Syed Sahib started catering to the needs of local troops. In 1922, Syed Sahib was awarded the first Export Award from the British Empire for his outstanding venture to supply footballs to the British Army camped in Singapore.

The sports goods sector bravely passed through the turmoil at the time of independence in 1947 when most factory owners, who were Hindus, migrated to India. The craftsmen, who were mostly Muslims, took over and greatly expanded the businesses.

In the 1970s, light metals like aluminum and titanium, became very popular in sports applications, due to their rigidity and lightness. However, since aluminum had low fatigue strength, even small stresses caused great fatigue and ultimate failure.

“A composite material is defined as a combination of two or more materials differing in form or composition on a macro scale that retains their identities”.

Initially, natural materials, like wood, were used due to its good shock absorption, but these materials had some drawbacks. The anisotropic nature resulted in low resistance and the variation in properties and high moisture absorption provided various deformations

¹Coordinated Monitoring of Participation in Sports

Why Composites?

Composites are able to meet diverse design requirements with significant weight savings as well as high strength-to-weight ratio as compared to conventional materials.

Composites such as glass/epoxy and carbon/epoxy, among others, have replaced

Fibers	Characteristics	Application
Carbon Fiber	Lightness, strength, resistance, and impact absorption	Skis, bicycle, frame and tennis rackets
Kevlar	Light weight, tensile strength, tenacity and impact resistance	Skis and protective gear
Boron	Resistance and good compression properties	Golf clubs
Fibre-glass	Rigidity, flexibility, low fatigue and resistance	Kayaks

metals. The anisotropy of these materials allowed the inclusion of greater resistance in applications where it is very necessary, like ski and protective gear. These composites offer greater stiffness, fatigue strength and damping in comparison to metals/alloys.

Table 1.0:²

Uses:

The use of composites in sports equipment depends on its purpose. For example, in some modalities, good shock absorption is needed, as in bicycle frame and tennis rackets.

Bicycles:

Composite bicycle frames have been largely an American phenomenon, as a spin-off technology from the aircraft and boating industries. Manufacturing of composites requires greater technical expertise and investment for product development. Carbon composite bike frame is a complex structure with performance

characteristics that include lightness, rigidity, durability, shock absorption etc.

As composites fabrication offers variation over the length of the tube providing different fiber angles, different layer thickness, and different combinations of materials. So the properties of the end product made from composites can be tailored to specifications.

Pakistan is yet to make a beginning in utilizing the benefits of composites in bicycle sector. In the near future, Pakistan can visualize rapid penetration in the bicycle components market as well as finished cycles. This would however, need the back-up of design/ processing technology of a high order, to be able to meet the international standards.

Sports Goods:

The optimum design of sports equipment requires the application of a number of disciplines, not only for enhanced performance but also to make the equipment as user-friendly as possible from the standpoint of injury avoidance. In designing sports equipment, the various characteristics of materials must be considered.

Among these characteristics are strength, density, fatigue resistance, toughness, damping, and cost. To meet the requirements of sports equipment, the materials of choice often consist of a mixture of material types - metals, ceramics, polymers and composites. Following are the general sports goods where there is a lot of potential for composites:

- Canoes and Kayaks
- Vaulting Pole
- Golf & Polo sticks
- Archery equipment
- Javelin
- Hand glider frame
- Wind surfer boards
- Protective sportswear

The benefits of Composites:

Year by year, more and more designers and engineers recognize the values of composites over other traditional materials like metal alloys, plastics etc. This is because composite material

²<http://www.fibrenamics.com/en/areas/sports/page/sports-equipment>

systems result in performance unattainable by their individual constituents. FRP³ are more reliable, more durable, easy and safe to use, more economical to produce, and individually solve many problems and offer many benefits. As a result, manufacturers are abandoning old materials and fabricating methods and turn to composites. Composites are no longer just the privilege of aerospace, defense and high priced products they are rapidly becoming a way of achieving high structural performance at a low cost. They are found in most of the cars we drive, in all busses, boats, and recreation and sports equipment such as skis or canoes.

Performance Advantage of Composites in Sporting Goods:

Composites have been increasing performance in sporting goods for many years: Tennis rackets (reducing weight and increasing the sweet spot size), Hockey sticks (adjusting kick point to increase energy transfer and puck velocity), and fishing rods (reducing weight, increasing the strength), arrows (increasing stiffness to decrease energy loss) and Canoes (reducing weight).⁴

Composites offer many advantages:

- Higher mechanical properties like strength and stiffness
- Lighter weight, higher performance
- Energy savings
- Durability, fatigue resistance and longer service life
- Impact resistance
- Dimensional stability
- Anisotropic properties
- Good chemical properties, corrosion resistance
- Fire retardant
- High temperature service
- Low maintenance requirements
- Low thermal conductivity
- Low or custom thermal expansion
- Flexible, tailor design, part consolidation and freedom of shape
- Combination of many materials and inserts
- Lower capital investment for FRP manufacturing facilities
- FRP products are simpler, having fewer and larger parts

- Relatively low energy consumption to produce raw materials.

Survey of Pakistan's Composites

Industry:

In 2011 it was proposed that a National Centre for Composites may be established at NUST College of EME to uplift the composites Industry of Pakistan.

A comprehensive survey was thus carried out to analyze the need for such a center and to identify the expectations of industry from such a center. Currently in Pakistan 120 to 150 small and medium sized organizations related to composites are operating.

Role of Research & Development:

As future trends, it is expected that the application of fibrous material in sports continue in constant evolution and development. The key areas for research in the near future are:

- To increase comfort and athlete's performance using new fibrous materials and structures;
- To monitor the vital signals;
- To evaluate the athlete's performance based on fibrous sensors;
- To exploit biomimetic, in order to obtain solutions that improve performance (reduce weight, reduce friction, hydro and aerodynamics).
- To find methods of Composite Materials to be recycled properly, in order to carter the environmental issues.

Future Business Opportunities

Strong developmental activities focusing primarily on products & processes need to be pursued in Pakistan. Towards such an objective, a multi-agency approach involving the industry, Government, academia, research laboratory, certification/standardization and user agencies would be required for a quantum jump in composite technology in the country. Thus, the key thrust areas may be summarized as here under:

³Fibre Reinforced Plastic

⁴<http://www.naefrontiers.org/File.aspx?id=36189>

- Application development
- Fabrication & testing support
- Availability & pricing of raw materials
- Manpower training
- Technical support services for materials & process selection, process optimization & design, product quality improvement etc.

Demands from Govt. of Pakistan:

- Recognition of composite based sports goods as special sector.
- Import of raw-material should be subsidize or facilitated by Govt. to save manufacture from custom duty, sales tax and other duties.
- Soft loans to establish new manufacturing units for composite based sports goods.
- Simplify the DTRE⁵ schemes.
- Sample shipments of raw materials/finished products be allowed duty free into country. Prompt clearance without delay and shipment track able system.
- Helping to form joint working groups with leading manufacturers to bring latest manufacturing technologies into Pakistan.
- TDAP assistance is required to send more delegations of composite based sports goods manufacturers to visit composite industrial units in china, Taiwan, Korea.

Requirements of our Industry:

- Low tech and medium tech manufacturers have no documented way of determining the mechanical, physical and chemical properties of the products.
- Medium tech manufacturers such as those for sports good and pipes keen on academia's input for improving their

process control parameters such as cure cycles.

- Needs to develop linkages with the academia like School of Chemical and Material Sciences (SCME), University of Sciences and Technology (NUST), with the faculty of Material and Science Engineering (FMSE), Ghulam Ishaq Khan Institute (GIKI), with Department of Polymer and Process Engineering (UET) Lahore, Pakistan Council of Scientific and Industrial Research (PCSIR) Lahore, Pakistan Product Design Center (PPDC) at the School of Art and Design (UOG) and TUSDECs Gujranwala Tools and Moulds Center (GTDMC), and Strategic Defense Organizations (SDO).
- For low and medium tech industries design is either being reverse engineered or just evolved through trial and error.
- Few producers of resin systems in Pakistan, however no quality standards in place to check what is being supplied, manufacturers complain about inconstancy between batches of both locally produced and imported resin systems.
- High tech industry although has large infrastructure but few experts, and thus requires training for both designing and manufacturing process optimization and further value addition to their products.
- Health and safety awareness is very low across industry and especially nonexistent for low tech industry.
- Low and medium tech entrepreneurs have shown a strong desire to have more value addition to their products and to move into more high tech products but are limited by the lack of supporting infrastructure and required knowledge.
- Across the industry requirement for training of low tech to high tech manufacturers all have shown a strong desire that academia helps them get awareness of and shift to better design and manufacturing processes.

⁵ Duty and Tax Remission for Exports

Conclusion:

Sporting goods in many cases need to be lighter or stiffer and composites materials are utilized to achieve this goal. Due

to the density and stiffness of composites one can achieve very different characteristics than metals. One can also design the material for the loading condition due to its anisotropic nature, further reducing weight and/or increasing stiffness in that plane or direction.

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