

# Opportunities of Composites in Sporting Goods Applications

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## Introduction

The composites materials are used in a variety of applications such as building & construction, pipes & tanks, automotive, aerospace, marine, electrical & electronics, consumer goods, wind energy, and many more. The consumer goods mainly comprise sporting goods, tool handles, and ladder rails. The sporting goods are having small chunk of total composites material consumption. The main sporting areas that have embraced composites are golf shafts, rackets, skis, snowboards, bicycles, fishing rods, baseball bats and hockey sticks. These all are manufactured by compression molding, hand layup, prepreg layup, wet layup, pultrusion, and injection molding.

The global composites market was estimated as \$ 85.2 billion in 2008 by value of shipments and is expected to grow at a good pace at 4.6% in the coming years as well. Out of this huge market, sporting goods applications take up a very small share of about 0.2%. The total consumption of composites in sporting goods was \$159.3 million in 2008. As penetration levels are still low in the sporting goods market for composites, there is still much scope left for the future. But there are some challenges as well like poor performance and high price, so if these are properly met, the market would be able to grow though the competitive nature. The total composites market for sporting applications is expected to reach \$300.8 million in 2014.

The heavyweight players are Aldila Inc, United Sports Technologies, Graphite Design International, True Temper and Fujikura Composites, Prokennex, Völkl, and Amer Sports.



Golf Shaft, Source: Aldila Inc

Why composites used in sporting goods applications?

The reinforced plastics continue to replace wood and metal in sporting goods applications such as in fishing rods, tennis racquets, windsurfing masts, hockey sticks, kites and bicycle handlebars, spars/shafts for kayak paddles, as well as in niche applications, such as fairings for recumbent bikes. The prepreg & prepreg based glass-reinforced, and carbon-reinforced are used along with epoxy resin mainly. The



Ice Hockey Stick, Source: Oxeon AB

reasons why composites are being used in sporting goods applications are depicted below as:

- Higher strength/weight ratio
- Higher mechanical strength
- Lighter weight
- Complex shapes
- Design flexibility
- Lesser vibration
- Cosmetic aspects
- Better and smoother finish

The golf shafts, racquets, skis, snowboards, hockey sticks, fishing rods and bicycles are consuming carbon mainly and it accounts for 63% by reinforcement while carbon prepreg has 31% share and the rest 6% is retained by glass and glass prepreg.

Carbon is mainly used in sporting goods applications due to their higher strength/weight ratio, higher mechanical properties and for being light in weight. It could have a modulus of elasticity up to 350 GPa as compared to a maximum value of 200 GPa for steel and the tensile strength of carbon is 3.5 GPa in comparison to a mere 1.3 GPa of steel. But the importance of all these characteristics is further complemented with the fact that the density of carbon fibres is one-fifth to that of high-tensile steel. The density of carbon fibre is a mere 1.78gm/cc while that of steel is 7.87gm/cc. This makes it a favourable substance to use in a number of applications where lower weight is an advantage but the reduction in strength is not acceptable and that's why composites is replacing wood and metal in sporting goods applications.

In sporting goods like the ones mentioned above, greater the mechanical strength, better will be the performance and life of the material. With lighter weight, the material is easy to handle and use. Force can be applied with ease and it is easy to move the object around. This aspect is particularly important in the case of sporting goods where light weight allows the player to manoeuvre the shaft or racket with the least amount of force needed. This gives the player a significant advantage over any rival who is using an ordinary shaft or racket. Carbons also allow the manufacturers of sporting goods to give a finer and better finish and also allow the material to retain their original shape for longer period of time, even withstanding greater pressures.



Snowboards, Source: Never Summer Snowboard Mfg

There are about a dozen suppliers of carbon fibres and glass fibres composites but almost 80 percent of market share is held by the major companies like Toray, Tenex, Zoltek, Wescorning, Jushi Group, CPIC and Taishan.

Key Challenges

- Toughness and impact performance
- Expensive production
- Shortage of skilled and qualified personnel

Market sizing by applications

Sporting goods is still a small fraction of the over all composite consumption. The main divisions in terms of composites consumption in this segment are as follows:

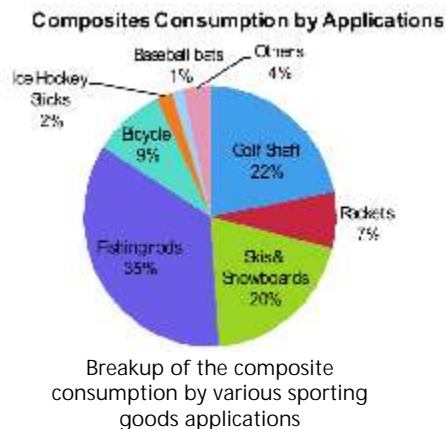
- Golf shaft
- Rackets (Tennis, Racquetball, & Badminton)
- Skis and Snowboards
- Fishing rods
- Bicycle
- Ice hockey sticks
- Baseball bats

Other sporting applications that have embraced the composites for the betterment in mechanical properties are boating, golf balls and tennis balls. But out of all the composites consumed today by the sporting goods manufacturers, 80 percent is taken up by the first 4 types mentioned above. The reason why composites have been embraced early by these sports is not very difficult to understand. The reason lies in the properties that composites enhance on their use in sporting goods. They are lighter than steel but very strong and

have high tensile strength as well, so, these characteristics are very useful when it comes to using a golf club or a fishing rod. In these sporting goods, light weight makes them easier to move at great speed and also since they have better mechanical strength, they can last long and hit the ball at great force.

In 2008, fishing rods accounted for almost 35 percent of all composites consumed by sporting goods applications, followed by golf shaft which is responsible for 22 percent. Skis and snowboards take up a close third with a percentage share of 20, followed by bicycles which take up about 9 percent and rackets which account for 7 percent of the composites used in the sporting goods industry. Hockey sticks and baseball bats account for 2 percent each of the composites consumption. Other smaller applications like golf balls take up the remaining 4 percent.

When we consider the carbon consumption split among the various applications, then we see a different picture as we saw for all composites consumption split. Golf shafts account



for the largest consumption of carbons for sporting applications with a share of 37 percent. Fishing rods account for 35 percent of all carbon consumption in sporting applications. Though fishing rod is the biggest consumer of composites, when it comes to carbons, then it falls behind golf shaft marginally, as glass is mostly used. Another

difference that we can see is while rackets fall behind skis and snowboards in composite consumption, in case of carbon consumption, rackets come up at the third place with a percentage share of 12 ahead of skis and snowboards (6 percent). Bicycles and hockey sticks account for 2 percent each.

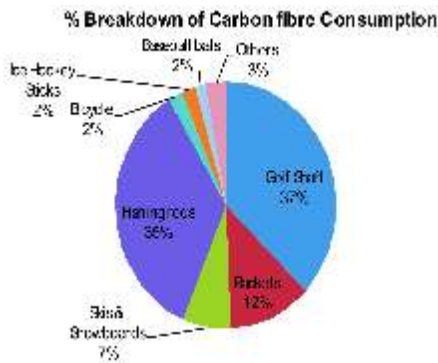
Because of cheap labour and cost of production and also due to subsidies provided by the various countries in Asia like China, Bangladesh, Malaysia, Korea, Thailand, India and even Japan, Asia is the leading producer of composite sporting goods. Most of the big sporting goods companies, though based out of North America or Europe, have their production centres in Asia. Asia-pacific retains number one position with 70% sporting goods production. Europe has a share of 17 percent while North America takes up the remaining 13 percent.

Golf Shaft Market

Golf has been one of the early adopters of composites in sporting applications. The shaft that was used was originally made of steel or costly materials like Titanium but steel had its share of problems. It made the shaft very heavy and so it was difficult to use it with ease. Another problem with steel is that it loses its original shape after passage of time and also there are minor irregularities on the surface which in turn leads to cracking after being in use for sometime. The rise of the composite golf shaft during the 1980s and 1990s powered a huge increase in the use of CFRP and had benefited by answering to a number of the problems faced by the conventional steel shafts.

Roughly 65 percent of all shaft productions now occur in China. Facilities in Japan produces the second highest at 18 percent, followed by Bangladesh at 7 percent. North America (U.S. and Mexico combined) accounts for only 10 percent.

The number of golfers in the primary markets, North America and Europe, has remained flat or fallen slightly since



Carbon consumption split among the major application areas in sporting goods

2000, and sales figures for many of the golf companies and their suppliers reflect this. China's growing consumer class is taking to the sport in a big way. The golf business is not only notoriously seasonal but also cyclical, conforming to a regular up and down pattern, year by year. Although shaft sales and deliveries, overall, have been down over the past 15 months, historic patterns indicate that the fortunes of shaft manufacturers should soon take an upward turn.

Further bolstering long-term potential growth, especially with the rising number of comfortably retired U.S. seniors, is a recent change in U.S. Golf Association rules, which now permit "quick connect" golf heads. While the extent to which the rule change will be exploited by golf club OEMs is not fully known, conceptually, the rule change allows a golfer to purchase multiple, interchangeable shafts for a single club, enabling an easy, on-course change to a shaft design that offers a particular ball trajectory or other desirable characteristic. Indeed, most OEMs are developing new products to exploit the rule change, but acceptance of the quick-connect concept in the custom club niche is uncertain, and any volume gains is likely to be gradual.

There are a few dozen companies worldwide that produce composite golf shafts, but slightly more than half of the total market share is commanded by five companies, namely, Aldila Inc, United Sports Technologies, Graphite Design International, True Temper and Fujikura Composites.

### Racket Sports

Racket sports, as we know, mainly covers three types of sporting areas, namely Tennis, Racquetball, Badminton and Squash.

Tennis owing to its popularity is played in almost all the countries in the world and has a huge following too. Hence, tennis rackets have the highest share in the overall composites rackets market and have a market share of 80 percent of all the types of rackets sold in the world.

Considering all the above mentioned sports together, there is a common thing among all of them, that is, the racket has to be light and strong, for making it easier for the player to carry it, swing it easily and also hit the ball/shuttlecock (in case of badminton) with much power. Conventionally, the frames of the rackets were made of wood or steel where both steel and wood had the problem of being brittle and also lost their shape after being used for sometime. In addition, there were small irregularities in the hollow steel pipe used or wooden frame which when aggravated resulted in cracks and finally the breaking of the racket. To counter these challenges, composites came as a big boon for the racket manufacturers particularly providing a solution for the high end rackets. While weight is reduced making it easier for the players to swing it with much power, it also helps in reducing the surface irregularities and hence prevents the development of cracks. In addition, the strength of the racket is enhanced. With prices following a reducing trend, the sales are expected to pick up for the racket markets, but there are also challenges which threaten to hamper their growth. They are the usual ones that are hampering the whole composite sporting goods applications market as a whole, namely the health hazard, low impact resistance and also higher pricing.

According to the Tennis Industry Association (TIA, Hilton Head Island, S.C.), the number of people in the U.S. who played tennis over the past five years has actually gone up to 10 percent.

Predictably, equipment sales to this sector are on the rise, although they have lagged behind participation rates. Badminton, particularly popular in Asia, is the world's fastest growing racquet sport, despite losing some following in the U.S.

Globally there are at least 40 racquet manufacturers, of which 20 manufacture tennis racquets. More than half of these manufacturers produce and market equipment and apparel specific to multiple racquet sports. Companies such as Wilson Sporting Goods Co., Völkl, and Head/Penn Racquet Sports produce racquets for all four sports and dominate market share.

Wilson, part of the Amer Sports (Helsinki, Finland) brand, is the undisputed brand leader, holding a 39 percent global market share. Rounding out the top five tennis companies are Prince Sports Group (Cumbria, U.K.), Prokennex, and Dunlop Sports Group (Surrey, U.K.). Combined, the five companies generate about 87 percent of total world output. Wilson and Head, by themselves, account for 63 percent of the total.

Although production numbers for tennis racquets are creeping upward, competition is driving costs down. As a result, nearly all tennis racquets (exceptions are the few smaller specialty brands) now are manufactured in China. This trend is well established.

### Skis and Snowboards

Skis and Snowboards are also benefited by the usage of composites. The strength and reduced weight are beneficial to both skis and snowboards. So, while traditionally, skis and snowboards were made of wood, they were very heavy and had many disadvantages like they used to break under slight stress and also were heavy. Even their life was very limited as their shapes used to get deformed after a certain usage period. So, snowboards and skis manufacturers started using composites so as to improve upon the physical attributes of the skis and snowboards. Unlike rackets and golf shafts, where carbon fibres are mainly

used, glass fibres with resins are the main composite used for skis and snowboards. But to increase the strength of the skis and snowboards, carbons are also added to the products on the higher side of the product range.

Since demand for skis and snowboards is heavily dependent on favorable weather, it is hard to mark with certainty the future buying trends. If global warming predictions prove accurate, participation and sales will continue to drop.

Market conditions have favored consolidation. Eighteen of the top 26 ski and snowboard brands are owned by four "multibrand" companies. Amer Sports Group purchased the high-end Salomon brand in 2005, which joined Amer's industry-leading Atomic brand. Not long afterward, apparel and surfboard manufacturer Quiksilver purchased Rossignol. The Tecnica Group recently acquired the Blizzard brand. Not surprisingly, Amer Sports, K2 Inc., Rossignol, and Tecnica Group together account for slightly less than 72 percent of unit volume and approximately 85 percent of sales.

Amer Sports, through its two main ski and snowboard brands, holds the leading market position.

### Fishing Rods

Fishing rod is also one of the major sporting applications where composites are being used. Both CFRP and GFRP are used in the manufacture of fishing rods. Glasses are much cheaper than carbons but it lacks in the sensitivity and strength of carbons. For fishing rods, both sensitivity and strength are important and can't be compromised with. So, carbons find greater usage in fishing rods than glasses. Wood was the main material used for fishing rods earlier. Even now, wood is the preferred material in the lower end of the product line, due to its low cost of manufacturing and also lower price but wood has the disabilities of being heavier in weight and also lower in tensile strength and has the tendency to crack under heavy loads. Composites brought about a better solution to

fishing rod manufacturers and since then have been one of the most extensive consumers of composites among the sporting goods applications.

Major companies producing composite fishing rods are Shakespeare, Shimano, Daiwa, Rapala and Gloomis and All Star Fishing Rods.

### Hockey Sticks

Hockey sticks are another major area of application for composites in sporting goods market. Hockey sticks need the strength to be able to hit the ball with great force and also need to be lighter in weight to help the player carry them easily and hit the ball with ease. Earlier sticks were made of wood and some used metals but that made the sticks heavier and also weak. The manufacturers came

Composites Sporting goods Production by Region



Breakup of the production of composite sporting goods

up with the usage of composites as the solution. Using glasses and carbons made the sticks lighter in weight and also gain in terms of strength. Also usage of composites enables a larger sweet spot which made it easier for the player to hit the ball to the right place on the field. However, the composite sticks have their share of challenges, like higher pricing and poor impact performance. But then, the composite hockey sticks have been successful in the market and has been increasingly gaining in terms of market share.

Major companies producing composite hockey sticks are Easton, The Hockey Company, Mission Hockey, Franklin Sports and Bauer Nike.

### Baseball bats

Baseball bat is still a niche market as far as composites are concerned but several manufacturers have been using composites for the high end bats in particular. This helps in not only making the bats lighter but also stronger and the player finds it easier to hit the ball at greater pace with much less effort on his part. Another major advantage gained by using composite bats is the reduction in vibration, thus it is much comfortable for the player to play his shots without any sting felt owing to lesser vibration. Though very highly priced at the moment as compared to the wooden bats, the composite bats are slowly making an impact in the market and a time is certain to come when majority of the baseball bats would be made using composites.

The major companies producing composite baseball bats are DeMarini, Easton, Louisville Slugger, Mattingly, and Mizuno.

### Bicycles

Bicycle is also a niche market as far as composites are concerned. The common material used in making bicycle frames is steel and aluminium and composites are mainly limited to high-end bicycles and for those used in sporting purposes. Using composites makes the bicycle lighter and stronger and also renders the ability to absorb vibrations better. As majority of bicycles are bought for general transportation purpose, most of the consumers are unwilling to pay the high price for composite bicycles. Hence, till date, the composites have been limited only to high-end bicycles, though things are changing and the sale of composite bicycles is following an upward trend. Reduction in weight and vibration gives the player the advantage of driving the bicycle with greater ease and attain greater acceleration and also ride through tough terrain. Both carbons and glasses are used in bicycles, but carbon, owing to their better ability to reduce vibration, is the favorite one though it adds to the price further.

The major companies producing composite bicycles are Seven Cycles, Calfee Design, Serotta Bicycles, Trek Bicycles, Cannondale Bicycles and Easton Sports.

### Opportunities in Other Sporting Areas

Major advantages offered by composites to sporting goods have become obvious from the points discussed above. Greater strength at lower weight enables a lot of advantages for sports which require quick movement and also great force. This is obvious from the sports that we had discussed so far. There are a number of other sporting areas which can be benefited from using composites. Following is the list of such prospective sporting areas:

- ⊗ Golf balls
- Pole Vaults
- Rugby balls
- Billiards cue shaft

Golf balls are other areas where composites are being used and an opportunity to make a big impact on those markets is bright. Balls made of

composites have double bounce than that of conventional balls. Pole vaults are another area where composites are slowly making their presence felt. The pole vaults made of composites are lighter and stronger and helps the vaulter. Rugby balls are also being slowly made of composites, though it is a niche market so far, but it is expected to increase at a good pace. Billiards cue shaft is also another upcoming application for composites.

### Conclusion

No doubt, composites has tremendous usage and opportunities in sporting goods applications, inspite of some challenges to be addressed like poor impact performance and higher costs, among many others, but still the market will provide great opportunities for those players who confront the challenges with the right approach. With reducing cost of manufacturing and increasing profit margins, the market will definitely pay dividends to manufacturers using

composites in sporting goods applications. But as the innovation cycle in sporting goods is short, the companies have to be on their toes as to develop better quality products at reasonable prices. In a nutshell, we can conclude that the sporting good market does provide a good opportunity for consumption of composites but there are some challenges, which if properly addressed will make the market a profitable one for the companies involved.



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