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Applications of Nano science in sports: An analytical study

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Abstract

In recent times, the sports equipment industry has emerged as a sophisticated yet commercially viable hi-tech industry where advances have revolutionized sports. Various Inter National Sports Competition like Olympics and World Cups have popularized the sports equipment industry up to a great extent, making it a lucrative business opportunity for public as well as private investors.

The degree of competitiveness in sports has been remarkably impacted by nanotechnology like any other innovative idea in materials science. Within the niche of sport equipment, nanotechnology offers a number of advantages and immense potential to improve sporting equipment making athletes safer, comfortable and more agile than ever. Baseball bats, tennis and badminton racquets, hockey sticks, racing bicycles, golf balls/clubs, skis, fly-fishing rods, archery arrows, etc. are some of the sporting equipment, whose performance and durability are being improved with the help of nanotechnology.

Keywords: Badminton, Nano science, analytical, Olympics, World Cups

Introduction

Nanotechnology is a science dealing with size at Nano meter scale. In this technology the scientist deals with materials at small size. Nano means “dwarf” which in turn means small. In the developing world nanotechnology is bringing change in almost all the fields like industry, medicine, defence, education, and business etc. The field of sports is also not an exception and more specifically the sports equipment and goods industry is also influenced by the Nano science.

Most of the sports equipment now a days are reshaped by using nanotechnology materials. Nanotechnology manipulates the matter at molecular level. IT plays an important role in changing the physical properties of matter at molecular level. The bulk material itself shows the physical properties quite different from materials at their Nano sized. Nanotechnology is giving a way to change the characteristics of many products. It turns back some salient features of material totally.

The control on this Nano scale gives confidence to scientist to create all kinds of products that we generally used in our everyday life. Therefore, scientists are showing their keen interest in improving the current sports technology of manufacturing sports goods and equipment by using Nanoscience.

Over the last few decades it has been observed that the use of a few new sports equipment like Tennis and Badminton rackets, racing bicycles, archery Bows and arrows, hockey sticks, etc. which are made with the help of Nano science had enhanced the performance of the players to great extent.

Use of Nano Science brings a change in the shape, elasticity and weight of equipment and thus make it stronger so that it can generate more power through it. Hence nanotechnology is providing an opportunity not only to sports persons to enhance their sports performance but also opening new gates for all those sports manufacturing companies.

Aim of the study

The main aim of this research paper is to have an analytical study of applications of Nanotechnology in sports. How the use of nanotechnology is helping in the manufacturing field of sports for the purpose of overall improvement in the sports performance of the players.

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Scientist always prefers those innovative ways in which the product material of sports equipment could be improved.

Review of Literature

Tina Harifi *et al.* 2012^[17] Applications of Nanotechnology in sports clothing and flooring for enhanced sports activities, performance, efficiency and comfort: a review; in the present paper researchers presented a review on applications of Nanotechnology in various sections of sports. Main attention had been given on clothing, sports flooring as well as on shoes. Researchers discussed special features of Nano technology in the field of sports. Nano technology would likely to bring a revolution in all types of sports wears.

Kerry Taylor Smith (2018)^[18]: Sports and Nano technology: Are the big sports looking to go small? Researcher explore the importance of small world in many equipment of sports. In various fields like water sports, golf club, shafts and light weight bike frames etc. the impact of low weight as well as high strength could be seen on commercial field.

Dimple Sethi *et al.* (2022)^[19]: Nanotechnology in sports equipment and sportswear; researchers explained the significant impact of Nano world on sports industries. The change in physical properties of the material at Nano scale is tremendously changing the features of many products in sports. To make the running shoes more comfortable to wear, the mixing of polymers with material at Nano size are giving improved results.

Qiuning Vien *et al.* (2022): researches conducted research on health care technology for badminton sports having a base of Nanotechnology. The paper focuses on 2 innovations. It analyses the growth related to value propositions in nanotechnology at company level. Secondly the research related to value propositions growth in nanotechnology at commercial level.

Lee CH believed that oil and water separation could be carried out using Nano technology. It would definitely work on the method of oil and water separation. He covered a comprehensive review on oil water separation using Nano technology.

Mirkin CA in his research discussed the advanced tools based on nanotechnology. The tools are impacting various research like the research in diagnosis of cancer and its treatment. This paper also explained the shape, size and other dimensions of any material at Nano scale which are dramatically changing their behaviour whether it is physical or chemical behaviour. There by the tools made by these materials are impacting the Cancer treatment.

Need and significance of nanotechnology in sports

The field of sports is very vast and diverging with different kinds of sports activities, various types of play fields, different kinds of rules and the varied demands of different sports making it more challenging. In modern society the expectations of sports fans are very high and they expect good performance from their favourite players all the times by any means. It is pertinent to mention here that in the overall performance of a sportsperson besides many more factors the quality of sports equipment being used by the sports person play an important role. Therefore, it is the need of the hour that the quality of the sports equipment and play fields be improved to enhance the overall performance of a player in any sports and is also equally important to save the player from many types of sports injuries to prolong his sporting career.

Nanotechnology help in making sports equipment lighter,

and more flexible. Nanoscience is related to material science and in order to produce the exotic sports products nanotechnology may be very helpful in changing the physical properties like size, shape, volume, colour, weight, temperature etc. Many Scientist across the globe are working hard to change the present characteristics features of sports equipment into the desired features for the betterment of the sports. Many sports manufacturing companies are taking the expertise of Nano scientist such as Nano-sys a famous company which works in Nano based materials.

Moreover now a day's many developing countries are investing a lot of energy, effort, time and money in the field of sports so that their sports person can perform better at international level. Scientist had found a way through nanotechnology to change the material's property as per the desire and requirement. Nanocomposites are helping them to mould the properties of equipment.

Nano materials and their applications in sports CNTs

CNTs are 117 times stronger than steel and 30 times stronger than Kevlar, the material used to manufacture bulletproof vests. At the same time, they are much lighter than steel. This makes them perfect to manufacture tennis racquets, handlebars for mountain-bikes, durable and race-bicycle structures. Bicycle Manufacturing Co. (BMC), manufactured a bike that weighed only 1055 grams using CNTs. The bike had 400 times greater tubular strength than steel. When used in golf clubs, CNTs reduce the weight of the clubs and lower the torque or spin of clubs. This makes swings much more accurate. Graphene oxide and buck paper (a sheet of CNTs) are incorporated into canoes or race-boats to help them glide across the water while making them stronger and lightweight. Sports equipment that shows at least 10-20% better performance/durability sells better in the market even if there is a steep price hike.

Silica Nanoparticles (SNPs)

Roger Federer has won many tournaments including the Wimbledon championships using Nano-enhanced racquets. He has used racquets enhanced with SNPs. SNP infused tennis racquets are stronger and have proved to have a 22% more ball-hitting probability than normal racquets. Largely due to the fact that lighter racquets offer better control and flexibility for the user. Fullerenes, Nano clay, and Nano titanium particles increase resilience and bounce of the ball and provide more accurate shots. SNPs are also added to skiing equipment to provide better flexibility control for skiing. This allows for much smoother rides, turns, and eventually fewer risks for injury.

Nano clay

Nano clay linings are added to footballs and tennis balls. These particles act as a barrier against the pressure the ball is subjected to during play. Nano clay lengthens the lifecycle of the balls. Athlete protective gear is also manufactured with Nano clay linings. This apparel offer increased durability. Moreover, they are weightless and thin enough to offer superior protection without hindering movement.

Nanotech in F1 Racing

All F1 cars and drivers must weigh the same for the best performance. However, the lighter the car is, the better handling is. Lighter cars allow racers to add ballast where they need to fine tune the balance of the car. Nanocomposites

can help here. They are infused into the car body making it lightweight and durable. Which is a must-have while speeding around turns. Additionally, nanocomposite particles can fill in the tiny gaps between the paint molecules and the metal of the car body. This can speed up the car.

The role of nanotechnology in F1 racing doesn't end there, nanofibers are added to brakes, and nanoparticles are added in lubricants to reduce wear and tear. McLaren has also used the A123 battery technology on its cars. The A123s nano phosphate lithium-ion batteries were successful due to the combination of weightlessness and better charge/discharge capacity. Nano-based paints are also used for thermal resistance and for reducing aerodynamic drag.

Water Repellent Nanoparticles in swimsuits

Sun Dry Swim makes use of quick-dry nanotechnology for swimwear fabric that practically wicks away water as naturally as skin. This swim wear is also assured to be completely safe for skin and is environmentally friendly. Nanoparticles are infused directly into the swimsuit fabric molecules. They form into a nanosomic membrane to provide a permanent water-repellent surface without compromising the fabric weave. The hydrophobic effect also means that the fabric is easy to clean. When water is not absorbed into the fabric, the fabric is lighter and swimmers will have added agility in the water.

Impact of Nanotechnology on Sporting Equipment

In recent times, the sports equipment industry has emerged as a sophisticated yet commercially viable hi-tech industry where advances have revolutionized sports. Various International Sports Competition like Olympics and World Cups have popularized the sports equipment industry up to a great extent, making it a lucrative business opportunity for public as well as private investors.

The degree of competitiveness in sports has been remarkably impacted by nanotechnology like any other innovative idea in materials science. Within the niche of sport equipment, nanotechnology offers a number of advantages and immense potential to improve sporting equipment making athletes safer, comfortable and more agile than ever. Baseball bats, tennis and badminton racquets, hockey sticks, racing bicycles, golf balls/clubs, skis, fly-fishing rods, archery arrows, etc. are some of the sporting equipment, whose performance and durability are being improved with the help of nanotechnology.

Nanomaterials such as carbon nanotubes (CNTs), silica nanoparticles (SNPs), Nano clays fullerenes, etc. are being incorporated into various sports equipment to improve the performance of athletes as well as equipment. Each of these nanomaterials is responsible for an added advantage such as high strength and stiffness, durability, reduced weight abrasion resistance, etc. in sporting equipment.

Various companies in the area of sporting equipment are coming up with innovative technologies/products, which include Double Core™ & BLX™ by Wilson (tennis), Air D-Fence™ & Nanolok™ by InMat (tennis), Nano-CFC® by Holmenkol (skiing), N-FUSED™ by Easton (archery), NSi™ from St. Croix (fly-fishing), Nanopreme™ by Yonex (golf), etc.

Over the years, with the evolution of materials in sports equipment, there has been reduction in the weight of equipment accompanied by considerable improvement in its strength. CNTs, the most frequently used material in Nano-enhanced sporting equipment have a higher specific strength

and specific stiffness than other conventional materials. They are 100 times stronger but 6 times lighter than steel and as stiff as diamond, which make them an ideal component for making sporting equipment where low weight and high strength are of prime importance.

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In addition to this various nanocomposites incorporating CNTs are far superior in terms of strength and durability to other conventional materials used in sporting equipment. CNTs are being used to create super-strong handlebars for mountain-bikes, durable tennis racquets and ultra-lightweight bicycle frames. Many champion road-racing cyclists such as Cadel Lee Evans and Floyd Landis won various tournaments including Tour de France using bicycles having CNT incorporated plastic frames. The *BMC SLC01 Pro Machine* bicycles used by these cyclists were manufactured by the Swiss company, Bicycle Manufacturing Co. (BMC), which weighed just 1055 grams (size 51), but possessed 400 times greater tubular strength than steel.

The famous tennis players like Rafael Nadal, Roger Federer, Novak Djokovic etc. have won many international grand slam championships using Nano-enhanced rackets (*Wilson n Six-One Tour 90, n Code & K Factor*) reinforced with SNPs. These racquets are more stable; stronger and have 22% more ball-hitting power than other non-Nano based racquets. Similar is the case in Badminton also where players like Lin dan, lee chong wei, Saina Nehwal, P.V.Sindhu, P. Kasyap, Sai Praneet etc. are using YY Yonex, Li ning and Carlton rackets empowered with Nano Science and they have won many international level championships. Carbonex and SNPs also impart flexibility control for skiing, allowing much slicker rides and turns.

Equipment such as footballs and tennis balls with Nano-clay lining as a barrier material uphold pressure for a longer game-play. Incorporation of nanomaterials (e.g. fullerene) lightens the golf clubs by lowering the centre of gravity, which increases the power and accuracy during the game-play.

Graphene oxide and Bucky paper (sheet of CNTs) are incorporated into canoes or race-boat hulls/masts to increase glide while making them stronger and much lighter. In ice-skating, ultra-hard Nano ceramics make the edges of skates super-sharp, whereas self-assembling bionic nanoparticles are used in land speed cars (*Royal Purple Streamliner* from Nish Motorsports & Nano tec-USA) to improve the fuel economy and speed even with 50% less nitro methane fuel mixture³.

In Formula One Motor racing, where race largely depends on the motor body-weight and type of tyres, lighter-weight and better-wearing nanocomposite products are being seized upon. Also, nanoparticles of ZrO₂, ZnO, CuO, etc. are used in lubricants for reducing wear and friction, carbon nanofibers are being incorporated in breaks and Nano-based paints are used for thermal resistance and aerodynamic drag reduction. Additionally, Nano-phosphate lithium ions batteries (Nano phosphate® from A123 System's, USA) are used in kinetic energy recovery systems (KERS), which are lightweight, have better charge/discharge capacity and efficiency.

Nano materials are the materials with at least one, two or three dimensions at nanoscale. Their area to volume ratio is large, having increased strength, improved chemical reactivity and conductivity etc. basically these are micro fabrications. At their nanoscale they often show unique optical, electrical and mechanical properties. Many Nano materials like carbon nanotubes or CNTS, Nano-clays, fullerenes or Bucky Ball, silicon nanoparticles are some examples which are being used in manufacturing of various sports equipment. These nanomaterials have different characteristics like light in weight, more durable, having high strength, elasticity and anti-bacterial nature etc.

The performance in sports competition is highly influenced by the quality of equipment a player use. The Tracks, courts, turfs and other sports grounds should be made with such type of materials so that the players are at minimum risk of injuries and the spectators as well as athletes can enjoy the game to its maximum. The advance Nano based sports equipment may be instrumental in changing the result of the competition. It has also been observed that the use of good quality equipment boost the confidence level of the player.

In recent times many sports federations are making their best efforts to popularize the Nano based sports equipment by highlighting and advertising the equipment and their manufacturing companies through international sporting events like Olympics, world cups, Commonwealth games, Asian games etc.

Carbon Nano tubes are Nano materials which can make light weighted and extremely strong sports equipment. Nanocomposite materials are used in badminton rackets, poles, baseball stager, tennis rackets etc. Nano silver is used in the preparation of Nano based jackets, costumes and towels etc. which can kill the bacterial infection. There are examples of famous tennis and Badminton Players who won many international tournaments with Nano technology based rackets. Following are some of the examples of sports equipment that has shown excellent results with the use of nanotechnology:

- **Sports Shoes:** In order to achieve the soft and squashy shoes the soft materials which can flatten, should be replaced with such materials which can allow the shoes to rebound after each step. The addition of hard bits to material can solve the problem. So the polymers of different sizes are combined with molecules of Nano size to achieve sole of shoes. Adidas, is using nanotechnology based nanomaterials and nanocomposites to improve the shoe quality.
- **Footballs and Tennis Balls:** In order to achieve such Nano based footballs and tennis balls which can uphold pressure for a longer time during a game, Nano-clay linings are used which can act as a barrier material to upload the pressure for a long time.
- **Skates:** To achieve the sharp edged skates during ice skating ultra-hard Nano-ceramics are helpful.
- **Cycling:** Carbon Nano-fibers are used to reduce the weight of the cycle and to increase the stiffness of bicycles.
- **Synthetic turf:** Need of synthetic turf in the field of sports is highly desirable due to some excellent features of synthetic turf. It last three times longer than grass, resistant to weather, having intense use, having no issues of mud traps, can save up-to to 10 lakhs gallons of water, cost effective maintenance. Hence it is a great substitute for natural grass.
- **Ballings:** Nanomaterials named fullerenes can reduce

chipping and cracking of balls.

- **Golf:** Nano nickel is used in golf now days to increase moment of inertia and stability of clubs.
- **Tennis and Badminton:** To make the rackets more durable, to resist the deformation, to increase strength, transmitting more power to shuttlecock or Ball for more accurate shots Nano titanium is used.

Conclusion

Popularity of sports all over the world is attracting sports scientist to use the knowledge of Nanoscience in the field of sports with the sole purpose of removing hurdles in sports performance like weight of equipment, ductility, elasticity etc. that can be minimized. Nano materials and nanocomposites, based on polymers, metals and ceramics are having large number of advantages over their bulk counterparts which can help us in manufacturing good quality sports equipment.

Nanotechnology, the advanced technology or smart technology is affecting the sports person, the sports guides, coaches, sports etc. In order to enhance the performance level many sports persons are taking interest adopting the Nano based sports equipment but some sports equipment of nanomaterials are very expensive and cannot be afforded by all players and hence scientist are putting their mind on such experiments which can minimize the cost of high-tech sports equipment.

Moreover, it is also desirable that due to Nano based sports equipment there should not be any toxic issue to environment. Keeping in mind the issue of pollution the proper monitoring on fabrication processes, the cost and the time is required. Hence it can be concluded that the use of nanotechnology in the field of sports manufacturing could be instrumental in overall improvement in sports performance of athletes and is also very helpful in minimizing the risk of sports injuries.

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