STUDY OF ANCIENT INDIAN SCIENTIFIC KNOWLEDGE AND CONTEMPORARY NANOTECHNOLOGY – A REVIEW

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Nanoscience and nanotechnology are at the forefront of modern research; it opens up a new outlook in the research and development of various disciplines like medicines, electronics, agriculture, cosmetics etc. The ancient Indians applied the knowledge of nanotechnology without explicitly mentioning the term. Damascus steel is a material used by ancient Indians for making sword containing carbon nanotubes. '*Bhasmas*' are generally used in ayurvedic medicines. These '*Bhasmas*' are the ashes obtained by calcination of heavy metal salts such as mercury, lead, arsenic, and iron and imparted with herbal formulation or with other ayurvedic constituents. Its particle size range between 5–50 nm. *Bhasmas* has some common properties such as anti-ageing quality, increases metabolism at the cellular level and acts as the catalyst. It can serve as an excellent template for the development of nanomedicine for an efficient therapeutic cure. '*Charak Samhita*', the most established Ayurvedic epic composed by the father of Indian Medicine, Charaka, mentions the cause for his medicine's potency is due to the reduced size of metallic and nonmetallic particles. Present-day nanotechnology is successful because of similar guidelines. A brief literature survey, regarding the ancient Indian scientific knowledge about nano-sized particles, their applications, strengthens the fundamentals of modern nanotechnology are the highlights of this present paper.

Keywords: Science and technology, Ancient India, Nanotechnology, Wootz steel, Ayurveda

Introduction

Indian sages, researchers, rationalists contributed their insight towards science and innovation well before the advancement of present-day science. Their hypotheses fortify present science and mechanical improvement. The invention of zero, estimation of pi by Aryabhatta, the idea of a molecule by Kannada, medical reference book 'Sushrutha Samhita' by Sushrutha are a couple of cases of their commitments.

It is said that the creation of a nano molecule is a wonder and offers extraordinary items and innovations in paint, texture, sustenance handling ventures, solution, data innovation, etc. Be that as it may, the use of Nanotechnology by antiquated Indians is all around talked about by Sir Walter Scott in his book "Talisman" in which he depicts the Damascus steel. The Damascus steel is a genuine really Indian origin steel. Wootz steel was made with a blend of an extensive amount of carbon and iron. This steel industry was all around created in southern India. The name Wootz is the western rendition of "ukku" and "ekku" of Kannada and Tamil. In Ayurveda, *Bhasma* is utilised to treat different illnesses. *Bhasma* of gold or silver metals was given to the diseased individual by goldsmiths, which was called *Swarna Bhasma*. *Charaka Samhita* discusses the extreme reduction of metal or non-metal particle size as evidence for the usage of nanotechnology in ancient Indians.

Objectives

1. To trace the ancient Indian Scientific knowledge regarding nanotechnology.
2. To interlink ancient Indian Scientific knowledge and contemporary technology with nanotechnology.

Nanotechnology

Nanotechnology is an emerging area of research and development in laboratories all over the world. The basic idea was started by physicist Richard Feynman in his talk entitled '*There's Plenty of Room at the Bottom*' at an American Physical Society meeting at the California Institute of Technology on 29 December 1959. He described a process in which scientists would be able to manipulate and control individual atoms and molecules. Norio Taniguchi, Professor joined the term nanotechnology. By definition, nanotechnology is the study and use of structures between one nanometer (nm) and one hundred nanometers in size. Nano-structure has unique properties that are exclusive due to its nano scale proportions, and based on nano scale proportions, it is classified into zero-dimensional (0D) (<100 nm, e.g. nanoparticles), one-dimensional nanomaterials (1D) (one dimension is outside the nanoscale. eg. nanotubes, nano rods, and nano wires), two-dimensional nano materials (2D), (two dimensions are outside the nanoscale. Eg. graphene, nanofilms, nano layers, and nano coatings) and three-dimensional nanomaterials (3D) (not confined to the nanoscale in any dimension, e.g. bundles of nanowires, bulk powders, dispersions of nanoparticles, nanotubes and multi-nano layers).

Quantum Effects

The reduction of the particle size from macro to micro dimensions does not show any significant quantum effect. In any case, quantum effects overwhelm the conduct of issue at the nanoscale, thereby affecting the optical, electrical and magnetic behaviour of materials. For instance, after achieving nanoscale, inert materials progress toward becoming catalyst (platinum), insulators move toward becoming conductors (silicon), solids transform into fluids at room temperature (gold), stable materials turn combustible (aluminium), opaque substances end up transparent (copper). Nanoscale materials have a relatively larger surface area. Hence materials become more chemically reactive and effective. These quantum effects are exhibited by the nanoscale, making nanotechnology very important in science and technology.

Research Questions

1. What do ancient scripts speak of nanotechnology?
2. Is there any relation between the ancient Indian scientific knowledge and technology with contemporary nanotechnology?

Nanotechnology in Wootz steel of ancient India

Robert Floyd Curl, Jr., Nobel Prize Winner in Chemistry in 1996, told the 95th Indian Science Congress's audience about the Damascus steel made by the experts of south-central India around 300 BC. He also said that Indian artisans used nanotechnology in wootz steel and painting. Russian scientists in 1952 announced that carbon nanotubes were found in Tipu Sultan's sword and Ajanta paintings. This is added as a monument to a glorious Indian tradition in the field of ferrous metallurgy. The fame of steel from India is well captured in the Arab Edrisi's (12th century) words who commented 'the Hindus excelled in the manufacture of iron and it is impossible to find anything to surpass the edge from 'Hinduwani' or Indian steel.

What made Indian swords so special?

These swords could bend at a 90 degree angle and immediately spring back to their former positions, and their blades are very sharp with spectacular beauty. Under the surface, wavy patterns crisscrossed in a unique design. According to anthropologist and archaeometallurgist Ann Feuerbach, Indian steel was originally shipped in the form of ingots to the Middle East and Syria. Because of the Syrian connection, the swords made with this steel were also known as Damascus swords, whose properties derived from the special way in which the steel had been produced.

Science and technology of Wootz steel

Wootz steel was prepared by heating black magnetite ore in a sealed clay crucible kept inside a charcoal furnace. A unique pattern of bands characterises it due to intermixed ferrite and cementite alloys in the steel. Reibold's team, on analysing under an electronic microscope, observed carbon nanotubes in wootz steel. The steel's elasticity and strength are due to the hexagonally arranged carbon atoms of carbon nanotubes, protecting nanowires of cementite (Fe_3C), and traces of metals including vanadium, chromium, manganese, cobalt and nickel. It isn't clear how ancient blacksmiths produced these nanotubes. Still, the researchers believe that alternating hot and cold phases during the manufacture of the steel caused metal impurities such as vanadium, chromium, manganese, cobalt and nickel to segregate out into planes. They would have acted as catalysts for the formation of the carbon nanotubes, which promoted the appearance of the cementite nanowires and may be the reason for the characteristic wavy bands in Damascus blades. This indicates that Indian blacksmiths were using nanotechnology at least 400 years before it became the scientific buzzword of the twenty-first century. During the eighteenth century, the ore used to produce wootz came from Indian mines that were depleted. As the particular combination of metal impurities became unobtainable, the ability to manufacture Damascus swords was lost. Now, thanks to modern science, which ultimately taught us how to replicate these superb weapons and, more importantly, the unique steel they were designed from.

Chemical analysis of Wootz steel

The chemical properties of wootz were investigated by great physicist Michael Faraday in 1819 and identified the presence of small amounts of silica and aluminium. French researcher Jean Robert Bréant appropriately inferred in 1821 that carbon is a necessary ingredient to give the steel its strength. The reasons for this strength, however, was unknown. In 1985, researchers Sherby and Wadsworth noted that the high carbon content of wootz results in a lower metal melting point. Using lower temperatures, Sherby and Wadsworth were able to produce strong steels with pattern comparable to Damascus blades. In 2006, however, researchers at the "Institut fur Strukturphysik" at the Technische Universität Dresden published the results of their detailed investigations where they claimed the presence of carbon nanotubes, a material that is on the cutting edge of nanotechnology!

The presence of single and multi-walled carbon nanotubes in Damascus steel would seem to explain the steel's legendary properties: both the steel and the nanotubes are renowned for their flexibility and strength. The Dresden group discovered remnants of nanotubes of iron carbide (cementite) in the Damascus steel in addition to the carbon nanotubes. Though such cementite is typically brittle, as high-carbon steel is expected to be, the evidence suggests that carbon nanotubes might encapsulate and protect the cementite tubes from damage.

It is quite fascinating to imagine, however, that ancient Mideast swordsmiths may have unintentionally taken advantage of nanotechnology that would not be esteemed until the modern era. Through a combination of ingenuity, observation, determination, and probably a lot of luck, these people managed to develop several surprising technologies — many of which have been lost to history and have proven surprisingly hard to reproduce today.

Ayurvedic Medicine in Ancient India

Ayurveda is a traditional medicinal ancient healing system. It consists of different types of treatments: aromatherapy, diet, herbal medicine, acupuncture, yoga, massage, meditation, and balancing of energies etc.

In 'Ayurveda', drugs derived not only from herbs but also from minerals, metals and animal products. Based on the source of origin, drugs are classified into *Jangama*' (animal origin) '*Audbhida*' (plant origin), and '*Paarthiwa*' or '*Khanija* (minerals origin). The processing of metals for their use in therapeutic formulations is described by Charaka in '*Lohaadi Rasaayana*' and by *Sushruta* with reference to *Ayaskriti*. The first step of preparation of both these formulations involves converting the metal sheet into a fine powder. By heating the metal to red hot, they are quenched in the different medicated liquids. This procedure gives powder of the metal sheets, which is then sieved through a thick muslin cloth. The sieved fine powder is utilised as a drug. These drugs are prepared using metal sheets of Gold, Silver, Copper or Iron in accordance with the specified requirement. In the post '*Samhita*' period, a new class of drug form termed as '*Bhasma*' came into existence by introducing two new techniques. '*Shodhana*' and '*Maarana*'. However, some minerals and metals like Biotite mica and copper may require additional steps like '*Amrutikarna*' and '*Lohitikarna*'. The term '*Shodhana*' refers to therapeutic purification. In contrast, the term '*Maarana*' refers to the incineration of metals or minerals by treating them with specifically prescribed medicinal herbs to convert hard metal or mineral into a fine and soft powder called '*Bhasma*'. Significant reduction in the particle size (1–2 μm) of these *Bhasma* helps absorb and assimilate the drug into the body system.

The nanotechnology of Ayurvedic Bhasma

Bhasmas are the ashes obtained by calcination of heavy metal salts such as mercury, lead, arsenic, and iron and imparted with herbal formulation or other ayurvedic constituents. To achieve the nano structure of *Bhasma*, selective metallic or mineral origin materials are exposed repeatedly to heat; "Puta". When *Swarna* (Au), *Tamra* (Cu), *Lauha* (Fe) and Mica (Biotite) *Bhasmas* are subjected to analysis under an electron microscope, it is found that they are similar to nanocrystalline materials. Its size of nano dimensions are usually 5–50 nm. These metal or mineral based drugs function best when converted from their original metal or mineral state to an oxide state. This converts the metal from its zerovalent state to a form with a higher oxidation state and eliminates the particle size by converting them into a biocompatible, bio-assimilable, absorbable, and suitable format for the human body. *Bhasma* have some common properties such as immunomodulation and anti-ageing quality, increases metabolism at the cellular level and acts as a catalyst. Bhasma is biologically produced nanoparticles with quick and targeted action, e.g., gold nanoparticles in *Swarna Bhasma* at 27 ± 3 nm size have been found effective in easing arthritis symptoms and at 4 nm size helped in increased apoptosis in B-chronic lymphocytic leukaemia. Few more examples of frequently used *Bhasma* include *Mukta Shukti Bhasma* (pearl-oyster calx) at 22.52 ± 0.45 μm size in acidity, pyrexia, tuberculosis, cough, asthma, etc., and also to increase the bone mineral density; *Mandura Bhasma* (iron calx) in microcytic anaemia and hemolytic jaundice, *Tamra Bhasma* (copper calx) as hepatoprotective and antioxidant, *Yashada Bhasma* (Zinc calx) in myopia, diabetes, leucorrhea, etc.

Ayurvedic Bhasma may hold strong relevance in the emerging era of Nano medicine and can serve as an excellent template for nano medicine development for an efficient therapeutic cure.

Conclusion

Even though science and innovation in the cutting-edge time have achieved things that our progenitors couldn't dream of, it is as yet worth remembering that the people in the past weren't fakers. It is fascinating to imagine, notwithstanding, that antiquated Mideast swordsmiths may have unintentionally exploited nanotechnology that would not be valued until the present day. The physicochemical investigation of *Bhasma* utilising present-day strategies astonishes us about the nanotechnology idea known by antiquated Indian researchers. Through a blend of creativity, perception, assurance, and most likely a great deal of good fortune, Indians figured out how to build up various incredible advancements. A large number of them have been lost to history and have demonstrated shockingly difficult to repeat today.

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