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USE OF NANOTECHNOLOGY IN ANCIENT INDIAN CHEMISTRY

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ABSTRACT

Nanotechnology is a multidisciplinary field with applications spanning agriculture, electronics, healthcare, textiles, construction, and cosmetics. Several hundred years back, India was advanced in traditional practices which were based on scientific knowledge. The Ancient Indian literature, Vedas and other texts demonstrate the intellectual property of Indians' thinking in a variety of fields of study such as philosophy, arts, science and technology. There was a significant development of chemistry in ancient India. There were number of evidences that prove the use of nanotechnology in various applications of chemistry. At that time people knowingly or unknowingly use this technology for better or surprising results. This understanding has paved the way for advancements in various scientific and industrial domains.

KEY WORDS: *Nanotechnology, Ancient India, Indian Traditional Practices*

INTRODUCTION

The foundation of nanoscience and nanotechnology can be traced back to physicist Richard Feynman's renowned lecture, *"There's Plenty of Room at the Bottom,"* delivered at the American Physical Society meeting at the California Institute of Technology on December 29, 1959. Nanoscience focuses on the study and manipulation of materials at the nanoscale ranging from 1 to 100 nanometers, enabling the exploration of unique properties that differ significantly from those observed at larger scales.

In India, the earliest applications of chemistry were especially in metallurgy, medicine, dyes, paints and in constructional technology. Indian craftsmen and artisans used nanotechnology extensively about 2000 years ago in making wootz steel and cave paintings (Ajanta Cave paintings). These ancient achievements shows India's historical connection to nanotechnology is both fascinating and deeply rooted in its ancient scientific traditions. Long before the term "nanotechnology" was coined

Metallurgy

There was significant contribution of chemistry in metallurgy in Ancient India. The technology used for making coins, utensils, ornamentals, weapons etc. shows high tradition of metallurgical skills. Metallurgy may be defined as the extraction, purification, alloying and application of metals.

India was a major innovator in the field, producing two highly advanced types of iron. The first, wootz steel, produced in south India from about 300 BC, was iron carburized under controlled conditions that is there was use of carbon nano particles in raw iron. Damascus swards are one of the amazing examples of application of nanotechnology in eighteenth century. Damascus steel (Wootz steel) blades contain nanowires, carbon nanotubes. It was reported the sward contains iron carbide particles (Fe_2C) known as cementite. These swards are highly flexible, sharp and mechanically very strong. The famous sword of Tipu Sultan in 18th century was made up of wootz steel. In Moghul era, wootz swords, knives and armours were artistically embellished with carvings and inlays of brass, silver and gold. Number of researchers worked to understand the composition and role of carbon in wootz steel and which leads to invent new technology of steel making.

The second type of advanced iron is the famous 1600-year-old Iron Pillar in Delhi. Due to its rust-resistant properties, scientists were curious about its composition. Chemical investigations showed that there is a presence of trace amount of phosphorus in the iron which forms a thin protective layer by using oxygen in air on the surface. The interesting thing is that if this protective layer is damaged by scratches, then it gets reconstituted. There are a few more such pillars in India, at Dhar (Madhya Pradesh), Kodachadri Hill (coastal Karnataka) and in Konarak's Sun temple. These evidences prove the high-level metallurgy skill of ancient Indian metallurgists.

The Herbal Kajal

Kajal is a black colored cosmetic used for decorating eyes. Women in India, following an age-old tradition inherited from ancient times by word of mouth. From ancient times Indians were expert in preparation of the herbal Kajal indicating use of nanotechnology. Kajal has been prepared since ancient times by the controlled combustion of coconut oil and collecting soot on silver plate. Now it has been proved that this synthesized kajal contains nanoparticles of carbon which have antibacterial

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properties. Carbon based nanomaterials have great importance in the field of cosmetics.

Cave paintings and Metal Coatings

Nearly 2000 years ago, Indian craftsmen and artisans employed nanotechnology to create enduring cave paintings, many of which still exist today across various regions of India. Notable examples include the Ajanta caves (dating from the 2nd century BC to the 5th century AD), Ellora, Bagh, and Kerala. Lesser-known rock painting sites in North India are found in Bhimbetka, Gwalior, Tikla, Ayra, and Bhanpura, while in South India, such paintings are present in Mahabubnagar (Andhra Pradesh), Edakkal, Marayoor, Perumkadavila (Kerala), Mallampadi (Tamil Nadu), and Bellary (Karnataka). Additionally, significant mural paintings are seen in Badami (6th century AD), Sittannavasal Jain cave temple (Tamil Nadu), Vijayalaya Choleeswaram temple in Narthamalai (9th century AD), the Brihadeeshwara temple in Thanjavur (11th century AD), and several temples in Kerala dating from the 16th to the 19th century AD.

Recent scientific studies have revealed the presence of carbon nanoparticles in Ajanta paintings, suggesting advanced material usage in ancient times. Additionally, goldsmiths in ancient India applied ultra-thin metallic films of gold and silver on statues and artifacts, enhancing their luster while increasing resistance to environmental wear and degradation. This demonstrates the sophisticated understanding of material science and nanotechnology by early Indian artisans.

Ayurveda- A Pioneer in Nanomedicine

Ayurveda has been a pioneer in pharmaceutical and therapeutic nanomedicine, particularly through herbo-metallic preparations known as ‘Bhasma’. These nano-sized formulations enhance drug absorption and assimilation, making them a vital part of traditional Indian medicine.

The 7th-century development of ‘Rasa Shastra’ revolutionized Ayurveda by introducing advanced techniques for metal purification and particle size reduction. Ancient texts like the ‘Charaka Samhita (1500 BC)’ discuss methods for extreme metal size reduction, leading to the production of nanoparticles. Bhasma, biologically synthesized metallic-mineral preparations, have been used in Ayurveda since the 7th century AD**.** Metals such as gold, silver, copper, iron, tin, and lead were extensively documented in Vedic literature and Charaka Samhita (3rd–2nd centuries BC)**.** Siddha Nagarjuna (7th century CE), regarded as the father of Rasa Shastra, refined techniques like ‘puna-paka’ (prolonged heating) and ‘kupi-pakwa’ (bottle heating) to further reduce particle size. Historical records indicate that ‘Swarna Bhasma’, used in Makaradhwaja Ayurvedic medicine, dates back to the 1st millennium BC**.** This ancient knowledge aligns closely with modern Nanomedicine, demonstrating Ayurveda's advanced understanding of material science and therapeutics.

Agricultural Practices

After harvesting, many farmers in India traditionally burn crop residues in their fields, a practice followed for several years. The primary objective was to increase soil biomass and organic matter. Recent research has revealed that the burnt residue contains carbon nanoparticles**,** which naturally enrich the soil. This process enhances soil quality and reduces the dependency on chemical fertilizers, contributing to sustainable farming practices.

CONCLUSION

Although the concept of nanotechnology is relatively modern, its fundamental principles were known and applied in ancient India for centuries. Various historical records and scientific studies suggest that nanotechnology-based applications were extensively used, particularly in therapeutics and Ayurvedic medicine. Ancient Indian metallurgists exhibited remarkable skills in producing wootz steel and rust-resistant iron pillars, demonstrating an understanding of nanostructured materials long before modern science recognized them. Similarly, the preparation of herbal kajal, which contains carbon nanoparticles, indicates early knowledge of nanomaterials in cosmetics.

The presence of carbon nanoparticles in Ajanta paintings and the application of ultra-thin metallic coatings on artifacts further prove India's proficiency in material science and surface engineering.

Ancient Indian chemists developed advanced techniques for processing metals and minerals into fine particles, which were incorporated into herbo-metallic formulations known as bhasma. These nano-sized preparations enhanced the bioavailability and efficacy of medicines, enabling better absorption within the human body.

Recent scientific analyses have confirmed the presence of nanoparticles in ancient Ayurvedic drugs and minerals, many of which are still in use today. The Charaka Samhita and Rasa Shastra provide detailed descriptions of metal purification, particle size reduction, and controlled heating techniques, which closely resemble modern nanotechnology principles. Metals such as gold, silver, copper, iron, and mercury were processed into nano-sized particles and used for medicinal purposes.

This evidence suggests that ancient Indian scientists had a deep understanding of nano-sized materials and their unique chemical, biological, and therapeutic properties. Their advanced methodologies laid the foundation for many contemporary applications in nanomedicine and materials science, highlighting India's rich scientific heritage.

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