



A Glimpse into Nanotechnology of Ancient Times

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Abstract

This paper delves into the intriguing realm of ancient civilizations and their utilization of nanotechnology, a field often associated with modern scientific advancements. Through an interdisciplinary exploration, we uncover compelling evidence suggesting that ancient societies possessed a sophisticated understanding of nanoscale phenomena and actively incorporated them into their cultural, artistic, and technological practices. Drawing upon archaeological findings, textual analysis, and scientific inquiry, we illuminate how harnessed nanoscale materials for various purposes. Furthermore, we examine the philosophical and societal implications of ancient nanotechnology, shedding light on its role in shaping historical narratives and contemporary scientific inquiry. By providing glimpses into these ancient marvels, this paper aims to enrich our understanding of the interplay between human ingenuity, technological innovation, and the enduring mysteries of the past.

Keywords: Nanotechnology, Lycurgus cup, Maya Blue, Damascus sword, Dichroism.

1. Introduction

Nanotechnology, often hailed as a cutting-edge field at the forefront of modern science and innovation, might seem like a recent development. However, delving into the annals of history reveals a surprising narrative — the subtle but ingenious use of nanoscale phenomena in ancient civilizations. Long before the term "nanotechnology" was coined, ancient cultures unwittingly employed nanoscale materials and processes to create remarkable artifacts and achieve technological feats that continue to captivate the imagination.

As we embark on this journey through the corridors of time, we will uncover the subtle manifestations of nanotechnology in the craftsmanship of ancient cultures. From the sophisticated metallurgy of ancient Egypt to the mystical alchemy of medieval Europe, civilizations have left behind a legacy of nanowonders that challenge our contemporary understanding of science and technology.

This exploration invites us to reconsider the capabilities and knowledge possessed by our ancestors, recognizing their intuitive grasp of nanoscale phenomena. Join us in unraveling the untold stories of nanotechnology in antiquity, where the seemingly mundane materials of the past held extraordinary secrets at the nanoscale.

1.1. Nanotechnology

The word “nano” was originated from the Greek term nanos which indicates “little old man” or “dwarf”. Nanotechnology is the branch of science which studies the structures in the dimensional range of one nanometer to 100 nanometers. The ideas that rooted nanotechnology were explored in 1959 by famous scientist R. Feynman in his lecture “There's Plenty of Room at the Bottom” in which he predicted and outlined the possibility of nanosynthesis by strategically manipulating the atoms [1].

Nanomaterials are the foundation of nanotechnology and nanoscience. Nanotechnology is an extensive and integrative field that has emerged globally over the last few decades. It is the science of creating morphologies or devices using nanoscale building blocks. [2]. It has the potential to transfigure the way in which goods are engineered with wide range of functionalities that can be retrieved. However, it is being pivotal that these materials exhibit variety of properties such as chemical reactivity, electrical conductivity, optical behaviour, magnetism and physical strength as a consequence of their small size [3, 4].

Some nanomaterials occur naturally, whereas synthetic nanomaterials are developed of particular interest for many industrial and medical applications. These can be found in products such as sunscreen lotions, cosmetic items, athletic accessories, stain-proof clothes, electronic devices, tires, appliances, in addition to many other commodities and also put in use in medicine for diagnostic purpose, imaging and drug delivery [5- 9]. Nanomaterials have a much higher surface-to-volume ratio than their bulk material, which can result in higher adsorption which enhances their strength. At nanolevel, the quantum effects have

become even more significant in determining the characteristics of substances, which leads to unique electrical, optical and magnetic behaviour [10]. Bimetallic nanomaterials are composed of two different metals. These particles exhibit modified superior properties than those of the two individual metals present in it [11].

2. Nanotechnology in Ancient Times

Nanotechnology has been used since ancient times. It was familiar even in ninth century as the artisans in Mesopotamia could use the ideas of nanotechnology and fabricated sparkling surface of pots. Nanoparticles were also used in medieval period. Stained glass windows in Victorial churches were contained different sized gold nanoparticles incorporated in the glass. Certain shape and size of the Au NPs resulted various vibrant colours to the glass material [12].

2.1 Lycurgus Cup

The Lycurgus cup (Figure 1) is a Roman glass cage cup used in fourth century. It is an outstanding example of exceptional workmanship with a carved embellishment displaying scenes of the folk tale of King Lycurgus. The cup, which has 165 mm height, was produced from a blown glass blank about 15 mm thickness [13].



Figure.1. Lycurgus Cup with Two Distinct Colours

The Lycurgus Cup is most significantly famous for the abnormal optical effects displayed by the glass. In transmitted light, the glass looks in a dark wine-red, whereas in the reflected light it seems to be in pea-green colour [14]. This effect is called dichroic effect which was

gained by fabricating the glass with gold and silver nanoparticles. To better understand the phenomena of dichroism, scientists used transmission electron microscopy (TEM) to examine the cup in 1990[9]. The dichroism seen is due to the presence of nanoparticles with sizes of 50–100 nm (two colors). These nanoparticles are silver-gold (Ag-Au) alloys with an Ag: Au ratio of roughly 7:3 and around 10% copper (Cu) distributed in a glass matrix, according to X-ray investigation. The Au nanoparticles turn crimson due to light absorption (520 nm). The absorption of bigger particles causes the red-purple color, whereas light scattering by colloidal dispersions of Ag nanoparticles larger than 40 nm causes the green color. The Lycurgus cup is one of the first synthetic nanomaterials. Early medieval church windows, which have a bright red and yellow color due to the fusing of Au and Ag nanoparticles into the glass, had a similar effect [15].

2.2 Damascus Sword

The Crusaders first used the blades of Damascus steel sword (Figure 2) in seventh century during medieval period while fighting with Muslims. They had a characteristic wavy banding pattern known as damask, which had superior mechanical properties with unusual sharp cutting edges [16, 17].



Figure.2. Damascus Sword

HRTEM images of samples of the Damascus steel revealed that those blades contained nanowires of iron carbide (cementite) and carbon nanotubes. These complex structures might be responsible for the tremendous hardness and extreme sharpness of the blades [18, 19].

2.3 Maya Blue

Maya blue is a colouring matter that was widely used in paints of ancient times in Mesoamerica (Figure 3). This paint was used predominantly during the classic and post

classic periods (AD 300-1519) from northern Yucatan to highland Guatemala and central Mexico [20]. It is not affected by any acid, base, solvent or reagent even after so many years of hot climate of Mesoamerica. [21].



Figure.3. Maya Blue Wall Painting

HRTEM and X-ray analyses of the samples of maya blue paints show the presence of palygorskite (magnesium aluminium phyllosilicate) crystals that are mixed with indigo molecules with encapsulation of oxide nanoparticles on the surface [22-24].

2.4. Faraday's Ruby Gold Nanoparticles

In 1857, Michael Faraday studied the formation and properties of "Ruby" gold colloidal suspensions. Their optical and electrical characteristics set them apart. Because of their unusual optical and electrical properties, they are among the most captivating nanoparticles. Faraday established how gold nanoparticles generate multi-colored solutions under specific lighting conditions [25].



Figure.4. Ruby Gold Colloidal Suspensions

3. Conclusion

Examining the long history of human inventiveness reveals that nanotechnology is not a new development but has quietly weaved itself into the framework of human history. Antiquity's investigation of nanowonders challenges our assumptions about the linear advancement of scientific knowledge while also highlighting the amazing achievements of earlier civilizations.

We are reminded that innovation has deep historical origins as we wrap up our tour through the corridors of ancient nanotechnology. Historical accounts reveal an enduring reality: humans have always been fascinated by and drawn to the challenge of comprehending and working with the tiniest. When we think back on the scientific marvels of the past involving nanotechnology, we are inspired to recognize the fundamental relationship that exists between our current achievements and the groundwork that our forefathers laid. Their quests for nanotechnology have left a lasting legacy of human ingenuity and curiosity that cuts across historical boundaries, uniting the past and present and pointing us in the direction of a constantly changing future.

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