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The Impact of Nanotechnology on Nanoart to Create Artwork: An Analytical Study

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ABSTRACT. *Nanotechnology is the ability to restructure and control matters at molecular levels. They are manipulated or arranged at the nanoscale form to provide better coatings, composites, or additives to create new materials with fundamentally new properties and functions. When the size of a particle changes, it can change colour. That is because, in Nanometer-scale particles, the arrangement of atoms reflects light differently. Gold, for example, can appear dark red or purple; silver can appear yellowish-Coloured. For the principle of teaching decorative design curricula in the technical education department (TED) in the State of Kuwait, the importance of the artistic values of visual art is for monitoring and sampling some of the creative Nano artwork collections. The present research discusses how Nanoparticles are classified on their application, utilising the engineering technology technique in response to Nano artwork visualised with a scanning electron microscope (SEM) and painted for innovative artwork.*

KEYWORDS: Nanotechnology, Nano artwork, Nanoparticles.

INTRODUCTION

With the advent of nanotechnology, it is known to have the capacity to create optical materials originating from the bottom up, with dimensions on the order of the wavelength of light. At the same time, it has been recognised that nanoparticles display such exciting properties for some time. Comprehensive nanoparticle research has significantly expanded our understanding of manufacturing and using nanoparticles for many surviving and emerging optical applications. Radical modifications to standard materials 'bulk' optical properties in these applications are possible, facilitating 'Nano-engineered optical properties with numerous degrees of design freedom, including material, size, morphology, encompassing media, and nearby structures. Understanding this responsiveness has led to visual control from the ultraviolet through the infrared spectrum.

The following review provides a comprehensive snapshot of how these impacts have been captured in models and experimentally demonstrated spectral selectivity in absorption, scattering, and emission. In addition, the recent progress towards using nanoparticles in real applications was discussed as a method to create the next generation of highly scalable and (possibly) low-cost spectrally particular optical materials. It is possible to obtain Nano-engineered materials that enhance our ability to control light and its influence on artwork. Advances in materials invention techniques have enabled bespoke Nanomaterials, which can be tuned to absorb undesired or damaging wavelengths, selectively convey and reflect desired portions of the occurrence spectrum and spatially redirect components of the spectrum.

The topic and aim of the research

General Purpose:

This study aims to realise the researcher's interest in Nanotechnology application of Nanoart work to improve the current curriculum program.

Specific Purpose:

- For the principle of teaching decorative design curricula in the field of Technical Education Department (TED) in the State of Kuwait,
- To illustrate the importance of the artistic values of visual art with Nanotechnology techniques.
- To explain, monitor and sample some of the creative Nano artwork collections.

Research Questions and Hypothesis

General Question:

What problems are encountered in utilising Nanotechnology techniques?

Sub Questions:

1. What problems do the instructors in the art department face?
2. What are the barriers to applying the science of nanotechnology in arts?

The hypothesis of the research

The present research hypothesises that nanotechnology education is a complex process. Most instructors encounter countless problems managing students' behaviours due to the lack of adaptable skills and talents.

Objectives of the research:

Provide students with timeliness for:

1. Generate Nanoart for Expressing Ideas, Attitudes, Sentiments, And Inflexions Through Varieties of Art Experiences;
2. Acquire the Proper Use of Nanotechnology, Nanoparticles in Modern Art, Equipment, And Materials.
3. Experience and Acknowledge Artworks of Nanoart;
4. Augment an Experience and Advance Intellectually and Culturally Through Nanoart;

5. Promote an Interest in Future Employment in Art;
6. Recognise the Application of Nanoart in Other Subject Areas.

Relevance of the research:

In aesthetic work and decoration, visual art is most interested in demonstrating the aesthetics and methodology of artwork by 3D nanoart. The above-stated purposes significantly emphasised that art students in higher education do not offer cultural and creative art in pre- higher schools. Furthermore, it is not proficient in properly self expressively. It has, therefore, developed the attitude and enhanced this new topic.

Definition of Nanotechnology

1. Nanotechnology includes the perception and control of the material at the Nanometer-scale, so-called nanoscale arrangements with dimensions of approximately 1 and 100 Nanometers. A Nanometer is a remarkably small unit of length—a billionth (10-9) of a meter. How minute is a Nanometer (nm)? An indivisible human hair is about 80,000 to 100,000 nm wide.
2. On the Nanometer-scale, materials may display unusual properties. For example, when the intensity of a particle changes, it can change colour. That is because, in Nanometer-scale particles, the composition of atoms reflects light individually. Gold can exhibit dark red or purple, while silver can exhibit yellowish or amber-coloured.
3. Nanotechnology can develop the surface area of material and more atoms to associate with other materials. An increased surface area is one of the goals Nanometer-scale materials can be stronger, more durable, and more conductive than their larger-scale (called bulk) analogues.
4. Nanotechnology is not microscopy. "Nanotechnology is not completely working at ever smaller dimensions," the National Nanotechnology Initiative says. "Rather, working at the nanoscale permits scientists to utilise the unique physical, indicating that art students in higher education do not submit cultural and creative art in pre-higher schools. Furthermore, it is not proficient in properly self expressively. It has, therefore, developed the attitude and enhanced this new topic.

Figure (1) Peacock's feathers are the result ofspacing between Nanometer-scale structures.

As the name intimates, Nanomaterials are those that occur naturally in the world. As shown in Figure (1) of a peacock's feathers, the brilliant colours appear from the spacing between Nanometer-scale structures on their surface.

Figure (2)

Wang (2012) and Nature's Color Tricks (2012) explained that the manipulation and utilisation of nanostructures are called nanotechnology. Butterfly-based new technologies are emerging through simple and effective approaches to nanotechnology, as shown in Figure (2). Using the structural and valuable properties of butterfly wings, as well as various unique functional materials, are exploited for the well-being of society. Most of the blue and green colours in butterfly wings are distinguished due to the wing scales' microstructures (300-700nm). These structural colours have a noticeable range of about 300-700 Nanometers. It is the physical colour resulting undividedly from the synergy of light with structures on the butterfly wings. The interaction of light with a Nano-rough surface can lead to constructive or destructive interference. Colour energy or an angle of luminosity depends on the thickness angle, and frequency of incident light. With this characteristic, several applications of Nanomaterials mimicking butterfly structures are reasonable.

CLASSIFICATION OF NANO-MATERIALS

1. **Magnetic Nanometer.**
   Magnetic Nanomaterials have superior properties to other nanoparticles, such as large surface area and good conductivity. In addition, magnetic Nanomaterials can be easily isolated from the solution (Xianzhen . et al., 2016).

   Graphene (GO).

Graphene is a typical two-dimensional carbon Nanomaterial (Jing . et al., 2019); (Lin, 2015); (Choudhary. et al., 2017). Graphene is a layer of graphite molecules stripped off

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the graphene sheet or formed by carbon nanotubes spread along the sidewall (Rui. et al., 2020).

- **GO** has attracted considerable interest in the design of biosensors due to its excellent physical and chemical properties. The fluorescence quenching of GO is one of the most important and classical characteristics of GO. Figure (3) shows a 3D render of a Flexible graphene sheet on a cloudy background [8].

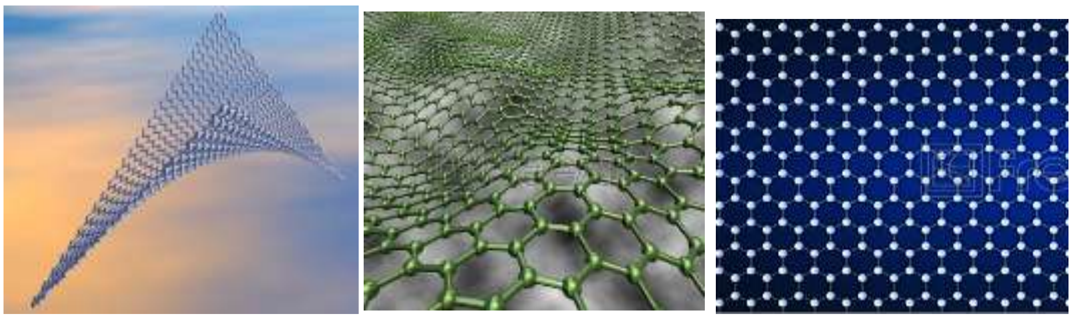

Figure (3)

- **Quantum dots (QD).**

Quantum dots have become powerful tools in biological imaging. Sensing and diagnosis are due to their unique optical properties, such as a wide range of adjustable size emission and absorption. Narrowing and symmetrical photoluminescence spectrum. Strong luminescence and good optical stability. Various QD-based sensors, such as fluorescence quenching and emission, have been developed to detect miRNA. There are also ways to detect metal ions using quantum dots.

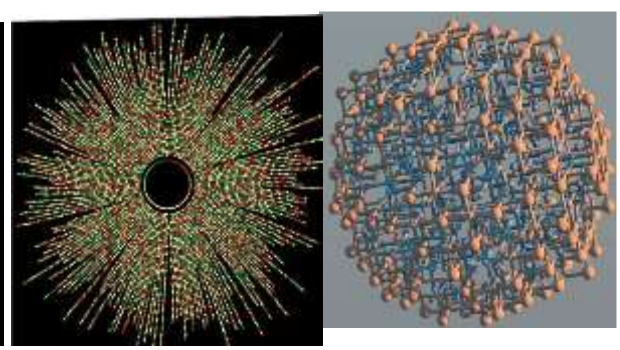

Figure (4A) Figure (4B)

Figure (4 A). Quantum Dot Samples under UV Light, as far as bringing the artwork to life with the texture and deepness of a stretched canvas print, the colour changed due to the concentrations of the particles.

Figure (4B) Joy of bubbles: canvas print by Cristian Ilies Vasile, the artwork structured with the texture and deepness of a stretched canvas print.

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2. Carbon Nano Tubes (CNT).

CNT can be performed by accumulating a large number of carbon atoms under certain conditions. It was found in carbon fibre produced by carbon nanotubes (Freeart.202), which can be seen as cylindrical structures formed by spinning graphene around a central axis. Figure (5) shows carbon nanotubes in artwork (Istockphoto 2022). Emissions have been developed to detect miRNA. There are also ways to detect metal ions using quantum dots.

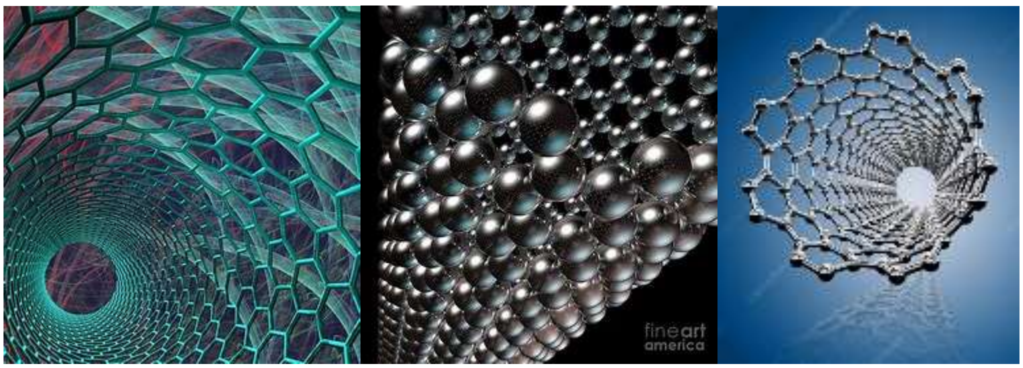


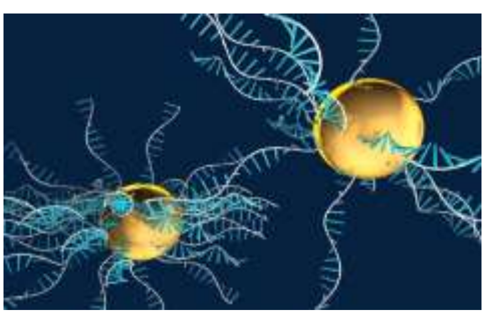
Figure (5) Carbon nanotube as computer artwork.

3. Gold Nano Particles.

Due to the characteristics of local surface plasmonic resonance (LSPR) of gold nanoparticles (AuNPs), a colloid AuNPs-based colourimetry sensor with visible colour change can be designed [Lin. et al. (2015); (Asadi . et al., 2015). As a result, AuNPs appear reddish when dispersed in solution and blue when aggregated. Due to the observable part phenomena in the spectrum, any changes can be detected with the standard UV-vis spectrophotometer and the naked eye (Zhu . et al., 2018).

- **Gold Nanoparticles with RNA**

Gold nanoparticles can be fabricated in any size, then functionalised and delivered into the cell through the cell membrane.



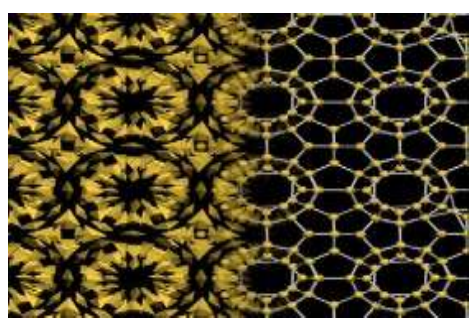


Figure (6) Figure (7)

Figure (6). Gold Nanoparticles with RNA as a photograph by Ella Marus Studio (2017). (Ella, 2022).

Figure (7). This image shows the gold nanoparticle bipyramids assembled into a complex crystal structure known as a clathrate. Image: by Glotzer Group, University of Michigan. Copyright: Science (Ella, 2022).

Properties of Nanoparticles

In 2008 the (ISO) Nanoparticle established a nanoparticle as a discrete Nano-object wherever all three Cartesian dimensions are scarcer than 100 nm. The ISO standard similarly restricted two-dimensional Nano-objects (i.e., Nano-discs and Nameplates) and one-dimensional Nano-Objects (i.e., Nanofibers and Nanotubes).

There are three influential physical characteristics of nanoparticles, and all are interrelated:

- They are extremely motorised in the Free State (e.g., in the nonexistence of a 10-nm-diameter Nano sphere of silica has a sedimentation rate under the gravity of 0.01 mm/day in water);
- They have tremendous specific surface areas (e.g., 6 ml of 10-nm-diameter silica Nano spheres has a higher surface area than a dozen twice-sized tennis courts; also, a 20 % of the whole atoms in individual Nano spheres will be established at the surface); and
- They may display what is distinguished as quantum impacts. Thus, nanoparticles have an enormous assortment of compositions, depending on the product's performance.

Nanoparticles are made by one of three tracks:

- Comminution (the pulverisation of materials) through manufacturing milling or natural weathering;
- Pyrolysis; by sol-gel structure.
- A sol-gel process bottom-up approach.

Nanoparticle applications in materials

Nanoparticles are related especially to the particles' size. It is, therefore, natural to attempt to capture some of those features by incorporating nanoparticles into composite materials. For example, how nanoparticles' unique properties have been used in a nanocomposite material such as the modern rubber tire (an elastomer) and an inorganic filler (a reinforcing particle).

Nanoparticles in the environment

Nanoparticles happen naturally in the environment in huge volumes. For example, the aerosol of sea salt issues that swims around in the atmosphere in various sizes, from a few nanometers upward, and smoke from volcanoes and fires contains a huge variety of nanoparticles. Dust from deserts, fields, and even trees release nanoparticles of hydrocarbon compounds such as terpenes that produce the blue fog seen in forests like the Great Smoky.

Large industrial processes transmit Human-made (anthropogenic) nanoparticles. In modern life, particles from power stations, jet aircraft, and other vehicles (namely, those powered by internal combustion engines; car tires are also a factor) constitute the major fraction of nanoparticle emissions.
Types of nanoparticles that emitted and partially burned hydrocarbons from vehicle exhaust catalysts). Metallic dust (from brake linings). Calcium carbonate (in engine lubricating oils). Silica (car tires).
Other sources of nanoparticles to the environment involve:

- The semiconductor industry.
- Domestic and industrial wastewater discharges.
- The health care industry.
- The photographic industry.

However, all those emission levels are still estimated to be lower than the nanoparticles produced through natural processes.
Nanoparticles are made by one of three processes:

- Comminution,
- Pyrolysis, and
- Sol-gel synthesis includes the production of Titanium nanoparticles for sunscreens from the minerals anatase and rutile.

LITERATURE REVIEW

Nanotechnology is the science of comprehending and monitoring material at very small dimensions (Office, 2018), (Serrano, 2009). For comparison, materials like gases, liquids, and solids may show extraordinary physical, chemical, and biological properties at the nanoscale, varying efficiently from the same material in bulk (Figure3). These enhanced characteristics incorporate augmented strength, lighter weight, more monitoring of the colour, and greater chemical responsivity. Such processes arise from quantum impacts, which govern particle performance and properties at the nanoscale (Lin, 2015), and from the greater surface areas of Nanomaterials. This increased surface area per mass lets more of the material touch adjacent materials.

As shown in Figures (8,9), the particles could be atoms, molecules or ions depending on the type of material, e.g., Ionic Compounds, Small Molecules, Giant Molecules, And Metals.

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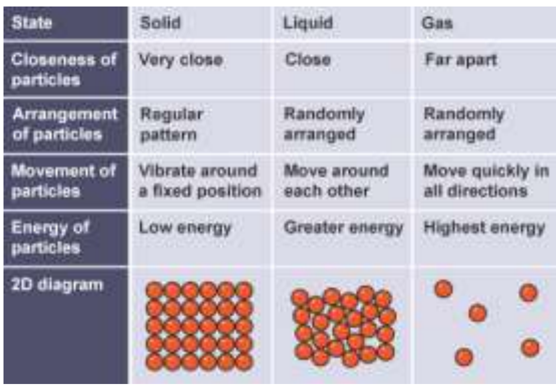

State	Solid	Liquid	Gas
Closeness of particles	Very close	Close	Far apart
Arrangement of particles	Regular pattern	Randomly arranged	Randomly arranged
Movement of particles	Vibrate around a fixed position	Move around each other	Move quickly in all directions
Energy of particles	Low energy	Greater energy	Highest energy
2D diagram			

Figure (8)

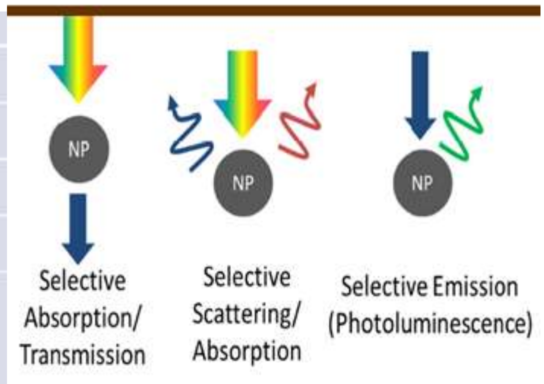

Figure (9)

SCIENCE AS ART

Nanotechnology and art (3D application)

NanoArt has been exhibited at traditional art exhibitions worldwide (Chau, 2003). The online contests started in the 2000s as the "NANO" 2003 exhibit at the County Museum of Art of Los Angeles and the "Nano mandala. The 2004 and 2005 establishments in New York and Rome by Victoria Vesna, James Gimzewski and the regular "Science as Art" section as launched at the 2006 Materials Research Society Meeting. Figure (10, 11, 12) show some of the NanoArt exhibitions.

Figure (10) is a 3D cross-sectional SEM (Scanning Electron Microscope) image of a lithium/solid electrolyte interface. The lithium metal nanoparticles interface with a firm electrolyte (shaded in red). The fish is simply a portion of lithium metal hanging from the original lithium. The foundation rock-like morphology is the dense electrolyte. On top of dense electrolytes, the electrochemical growth of lithium dendrites (screened in green) with curvy rods alike morphology. By using Adobe Photoshop to fake and colour this SEM image. (Photoshop credits: Sourayan Basu Bal)

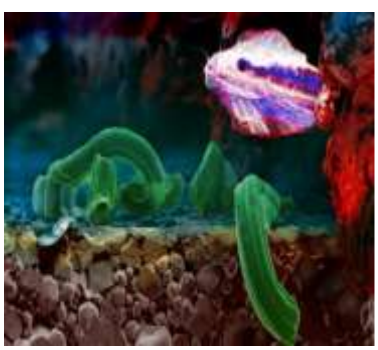

Figure (10)

Figure (11)

Figure (12)

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Artwork Description:
Fig (11) Nano Art 21 was founded in 2004 to encourage responsible Nanotechnology development through art. (nanoart21.2022). Figure (12). The artwork is "LA Marché des Aiguilles by Sara Coppola. The exhibition is nominated as the needles march". It represents a collection of biocompatible and functionalised microneedles for drug delivery. The exhibition illustrate Spectacular film "La Marche de l'empereur / March of the Penguins (2005)". The images were shot under photoluminescence emission. The microstructures are fabricated by physical intelligence driven by the pyro-electric effect.

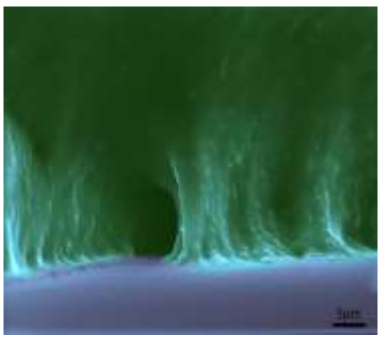
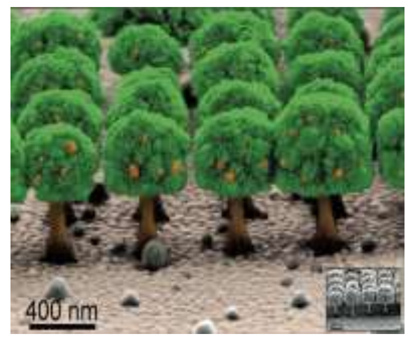


Figure (13)

Figure(14)



Figure(15)

Art science and engineering.
Artwork Description:
Figure (13) A Lithium Dendrite Aquarium created by Vikalp Raj
Figure (14) Water Lilies in the Moonlight created by Yadong Yin
Figure (15) La Marche des Aiguilles/ the March of the Needles made by Sara Coppola

"**NanoArt** is a new art development at the art-science-technology junctions. Its features are Nano landscapes (molecular and atomic landscapes) whilst natural material structures at the molecular; moreover, the structure can manipulate molecular and atomic scales. These structures could envision with powerful research tools like scanning electron microscopes and atomic force microscopes.
The scientific images are apprehended and further processed using different artistic techniques to convert them into artworks, as shown in Figures (13, 14, 15).

The following images are about the international juried and selected NanoArt competitions of the artworks collected in the NanoArt21 gallery, as shown in Figures (16,17,18) [18].

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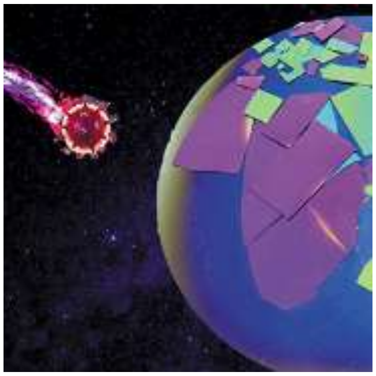
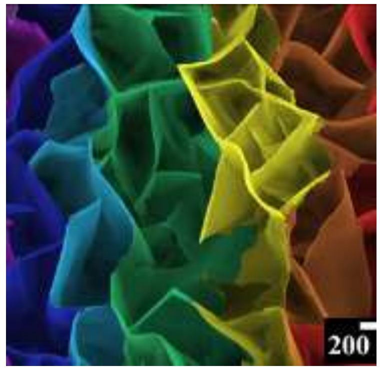

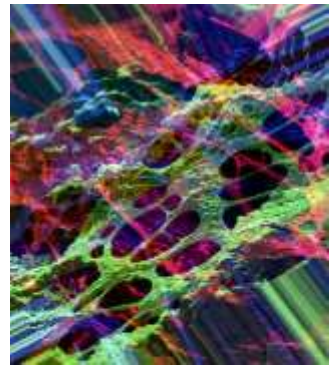

Figure (16) Figure (17)
Figure (18)

The Artwork Description:

- Figure (16): Called: The Silicon Planet vs Covid19. Comet Poorani Gnanasambandan, Luxembourg Institute of Science and Technology. The Silicon Planet is a collage of thin film on Si deposited using Atomic Layer Deposition Blue: 12-in Si monitor consisting of 91.84±2.32nm Mg O film Pink: Wafer pieces from 201.24±1.28nm ZnO film Green: 303.91±1.89nm Zn1-xSnxO films. The College has been Photoshopped into the background. Background stars and covid virus image: From Pixabay.
- Figure (17): Separated Yet Connected, Alekha Tyagi, Indian Institute of Technology. The image is a FESEM micrograph of a nickel sulphide-doped carbon hybrid nanomaterial for ORR catalysis with unique porous interconnected morphology. Lives are highly interconnected as a virus originating at one corner creates havoc worldwide. The COVID-19 pandemic confined us in narrow spaces (pores). Staying in touch with maintaining social distancing is important in these times to avoid anxiety and depression. The image is coloured like a rainbow to represent the combined efforts of different people worldwide to end this pandemic (realise a white (bright) future).
- Figure (18): called: Quantum Tunneling
  The image is Graphite micro-particles embedded in a polymer matrix. The structure was visualised using a scanning electron microscope (Applied Analytical Sciences, Costa Mesa, California). The image was captured in a computer and digitally painted, eventually printed on canvas with archival inks specially formulated to last long. This way, large audiences could view the Nano sculpture. Large prints are available by request.

Jennifer (2015) reported that merging art and science typically comes from Kate Nichols. The colours in her pieces do not proceed from pigment but tiny silver nanoparticles suspended in the paint. She makes them herself as an artist-in-residence in the University of California, Berkeley's nanotechnology research group, shaping nanoparticles more like soccer balls and suspending them in organic solvents. It could be got them to adhere to glass, as shown in Figure (19). Nichols Figured out exactly how the solvent dried, and the pieces would look in different lighting.

Under Wilson's tutelage, she acquired to perform her pigments out of lead oxide, linseed oil, as well as resins. On the other hand, Nichols's interest was stimulated by the blue-green iridescent hues of the Morpho butterfly.
In the Morpho case, these structures most strongly scatter blue light. As the butterfly moves, the hue flashes and transfers to lighter or darker blue. The result is produced iridescence. The Structural colour is similar to peacock feathers, fish scales, and beetle casings.

Figure (19) silver Nanoparticles on glass, 2014. Kate Nichols.

NanoArt International Online Exhibition

NanoArt is the interpretation of the New Technological Revolution, indicating the transition from Science to Art. Using technology could be for the 21st Century what Photography was for the 20th Century. Over the past two decades, the capability to measure and handle matter at atomic and molecular scales has directed the discovery of innovative materials and phenomena. These advances underlie the multidisciplinary regions known today as Nanotechnology. Orfescu (2021) envisioned the Academy as an international organisation for advanced education. The Academy offers resident programs with artist-scientist teams supplied a science labs/art studios equipped with electron atomic force and other advanced microscopes to visualise Nano sculptures and Nano landscapes and manipulate the matter at molecular and atomic scales.

NANOMATERIALS IN THE 3D INDUSTRY

Art and Nanomaterials in the Past Centuries

NanoArt goes back in time to the first uses of Nanomaterials and Nanotechnologies to generate art and continues with the origins of NanoArt. Then, it observes this new artistic-scientific regulation and the movement from recent technological developments in the multidisciplinary field identified as Nanotechnology. Nanomaterials have been practised to generate art objects like the popular Lycurgus cup in the British Museum in London. The cup's glass contains gold and silver Nanoparticles, making the cup change colours from green to red when light is shown through it, as shown in Figures (20, 21).

Figure (20) Figure (21)

Cup's glass contains gold and silver Nanoparticles

Using Nanoparticles in Glazes

In the 10th-11th centuries, stained glass started to grow as an art. Glass was naturally coloured by counting Nanoparticles of metallic oxides and metals to the glass while in a melted state. Copper oxides were added to create green, cobalt for blue, silver for yellow, and gold for red glass, as shown in Figure (22). After colouring, 'small pieces of glass are arranged to perform pictures, kept collectively (traditionally) by strips of lead and maintained by a rigid frame.

Figure (22) Canterbury Cathedral window, c. 140.

Deruta Ceramics [21]

Figure (23) Figure (24) Figure (25)

In the 15th and 16th centuries, ceramists in Deruta (Umbria region, Italy) created mixed metallic glazes using copper, cobalt, gold, and silver nanoparticles, to produce a combination of green, blue, yellow, and red, as shown in Figure (23).

Earlier, Deruta ceramics do not have the lustre. The lustred majolica of Gubbio owes its celebrity almost entirely to the work of Maestro Giorgio Andreoli (The Encyclopedia Britannica), who most probably learned the technique from a Muslim potter and developed it to perfection. Finished painted pieces were sent from other factories to receive the addition of lustre at Gubbio, as shown in Figure (24), a Bowl with a putto holding a pinwheel, ca. 1530.

In a painted ceramic, nanoparticles can differ from 5 to 10 nm in size and maintain a thin layer on the surface (Padovano et al., 2003). Nanoparticles can generate colour within the emission process of the surface plasma vibration, allowing light that hits the Nanoparticle to be reemitted at different wavelengths (Lambertson et al. 2017), (Ball, 2003)

A 15th-century vase from the Italian city of Deruta, the famous pottery town, is a major source of unique ceramics. The amber colour in Renaissance pottery originates its properties from copper nanoparticles. Image as shown in Figure (25).

International Organization

NanoArt 21 (Academy, 2022) was envisioned as an international organisation. It allows resident programs for artist-scientist teams to help realise this new method and create Nano artwork in science art. The lab studios are equipped with an electron atomic force and other advanced microscopes to visualise the Nano sculptures and landscapes. Research equipment to facilitate the creation and manipulation of matter at molecular and atomic

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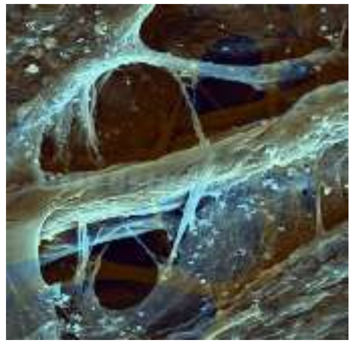
scales and artistic tools for Nano artists to help researchers convert scientific images into artworks. The art projects in a research background will excite the researchers to add artistic and emotional value to the scientific work, afford grounds for developing novel skills, and lead to discoveries, as shown in Figures (26,27,28) Cris,2022).



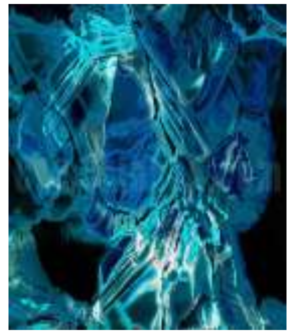


Figure (26) Figure (27) Figure (28)

The Artwork Description:
Figure (26) Nano Landscape – Nanopore in a carbon microstructure. The monochromatic scan has been composed and managed digitally, and the final image was printed on fine art paper with archival inks specifically formulated to serve for a long time.
Figure (27) Nano Sculpture was performed by casting a mixture of polymers and nanoparticles of carbon on a microscopic glass. With a scanning electron microscope, the structure was imagined. The monochromatic scan was then painted and manipulated digitally. The final painting was published on fine art paper with archival inks specially formulated to serve for a long time.

Figure (28) Nano Landscape – Graphite nanoparticles were formulated with a scanning electron microscope. The monochromatic scan has been painted, manipulated digitally and printed on fine art paper with special archival inks to satisfy a long time

Effect of Nano Particles on garment design art
The construction process of the work of Nanotechnology at State College, Pennsylvania (Gowayed,2005) has found a method to add silver and gold nanoparticles to clothing fibres to improve their characteristics. The nanoparticle procedure can either be a coating or incorporated into a thread, depending on the targeted properties and the type of fibre used. The Cornell Design League Fashion Show has created a dress and jacket containing Nanoparticles with antibacterial and air-purifying qualities. The upper division of the gown holds cotton coated with silver nanoparticles designed positively by charging cotton fibres using ammonium- and epoxy-based reactions, producing positive ionisation (Byko, 2005). The silver particles were synthesised in citric acid, preventing Nanoparticle

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agglomeration. The resultant colours are not the product of dyes but reflections of particle size or arrangement manipulation. The structural colours, however, are non-toxic, more vibrant and durable. In industrial production, however, they have the drawback of being strongly iridescent, which means that the colour perceived depends on the viewing angle, as shown in Figures (29, 30, 31)

The Artwork Description:
Figure (29). Gold Nanoparticle with a diameter of 100 nm in media with refractive indices of 1.00,
1.33, and1.45, as labelled in the Figure.
Figure (30). Illustrating side effects for a gold Nanoparticle with a diameter increasing from 50 to
100 to 150 nm.
Figure (31). Simulated spectra of Nanorods with a short diameter of 10 nm and length of
60, 70, and 80 nm.

Figure (29)

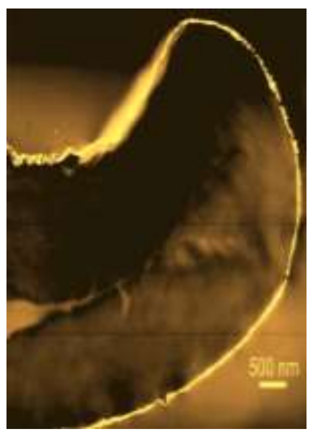

Figure (30)

Figure (31)

DISCUSSION AND CONCLUSIONS

Colours can be produced in a variety of ways. The best-known colours as an old fashion are pigments. However, the very bright colours of the peacock feathers are not due to pigments; they came from nanostructures, causing the reflected light waves to overlap—this technique produces extraordinarily dynamic colour effects. Nanotechnology is one of the most quickly rising fields of translation of Nano artwork imagined with a scanning electron microscope (SEM) and painted for creative artwork. *Nano*art's work should use Nanotechnology sources as an environmentally friendly agent for its advancement and development.

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The development of multiple facile synthesis techniques could be used to innovate nanoparticles of various materials in shapes and sizes. Nanoparticles display an attractive and low-cost method for achieving particular spectral filtration. The spectral properties can be readily harmonised and scaled to large volume production—moreover, the relatively small amount of nanoparticles needed to achieve outstanding absorption results at a low cost. However, metallic nanoparticles have displayed a large level of harmonising in the visible spectrum through particle size and morphology.

Another remarkable peculiarity of nanoparticles over other optical filtration technologies is that they can serve as a building block for multiple applications. For example, the Nanoparticles could be dispersed in a fluid or applied as a thin film. If scattered in a liquid, they could be mixed, separated, and pumped in and out of an application. While commercial products are limited primarily to paints, new products that utilise the unique optical advantages afforded by nanoparticles may be forthcoming.

Future Research

Teaching Strategies Nanotechnology (Education, 2021) should be conducted by creating both knowledge- and learning-cantered environments inside and outside the classroom. Because technology is advancing so fast, activities that encourage creative thinking, critical thinking, and life-long learning should be prioritised. Nanotechnology is truly interdisciplinary. An interdisciplinary curriculum encompassing a broad understanding of basic sciences intertwined with engineering and information science pertinent to nanotechnology is essential. Introductory Nanotechnology courses should be taught more from development and qualitative analysis perspectives than mathematical derivations. Junior and senior design courses, specifically the capstone design courses, should integrate modelling, simulation, Control and optimisation of Nano devices and NanoSystems into the course objectives. Interactive learning should be the symbol of nanotechnology education. Technology can play a powerful role in facilitating interactive learning inside and outside the classroom. University faculty members must collaborate with the industry to educate and train students in the field of nanotechnology. Utilising a team of faculty members specialising in appropriate disciplines to teach nanotechnology courses is highly desirable. Including guest speakers from industry and research centres enhances the quality of available classes. Governmental bodies, industry and universities must take the initiative to allocate additional funds toward faculty development in nanotechnology.

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