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Biodeteriration Of Cultural Heritage And Their Conservation Through Traditional Method Of Conservation

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Abstract: Over the past several years, there has been a growing focus on the conservation of cultural heritage on a global scale. This is primarily due to the persistent dangers that are posed by the degradation of artefacts and monuments. Therefore, it is of the utmost importance to locate competent consolidators that are capable of preserving and preserving the intrinsic properties of these products. The objective of this research is to provide a comprehensive review of the key nanomaterials that are utilised in the process of preserving and restoring cultural heritage. In recent years, there has been research conducted to determine whether or not tubular nanomaterials, such as carbon nanotubes, have the potential to operate as a viable medium for the consolidation of cultural heritage. Aside from the conventional nanomaterials, which include hydroxyapatite, carbonated derivatives, metal nanoparticles (copper and silver), metal oxides (zinc and aluminum), and metal nanoparticles, this is an additional nanomaterial that has been utilized in this sector of the economy. Due to the fact that tubular nanotubes have a broad variety of walls and topologies, which makes them suitable for a variety of applications, a wide variety of industries are interested in them. These nanotubes have all the necessary characteristics to preserve cultural heritage because of their superior mechanical and elastic strength (even greater than steel), high hydrophobicity (with a contact angle of up to 140 degrees), optical properties (high photodegradation protection), large specific surface area (ranging from 50 to 1315 m2/g, depending on the number of walls), ability to absorb other nanomaterials, and relatively good biocompatibility.

Key Words: : North American carbon nanotubes, biodeterioration of South Indian, characteristics, superior.

It is imperative that cultural heritage be protected in order to protect not only the historical record of humanity but also the structural integrity of buildings and objects. The term "artefact" refers to any article of historical value that has been crafted or transformed by individuals throughout the course of time. Any item discovered during archaeological excavation that has the potential to be of cultural importance is referred to as an artefact. Problems with degradation pose a persistent threat to these relics from time to time. For instance, the structural integrity and mechanical strength of stone, paper, and wood artefacts are significantly influenced by a variety of important degradation components that are continually present. These aspects include degradation that can be caused by chemical or biological processes, which can lead to the material breaking down overall. nanoparticles, which range in size from one to one hundred nanometers, possess higher surface areas than larger-scale materials that are similar in size. This means that nanoparticles may be able to penetrate damaged remnants to a greater depth.

Because of the unique characteristics that they contain, nanomaterials have attracted a lot of interest in the subject of cultural heritage over the course of the past several decades. The acquisition of innovative systems has been the subject of recent publications that have been published in the scientific literature. Metal hydroxides and oxides, such as titanium dioxide (TiO_2), zinc oxide (ZnO), calcium hydroxide ($Ca(OH)_2$), magnesium hydroxide ($Mg(OH)_2$), and strontium hydroxide ($Sr(OH)_2$), are included in these systems. The potential of these systems to function as consolidants on a wide range of objects and creative works is another advantage they provide. Metal oxide nanoparticles, for instance, have been used over the course of the past ten years to protect the surfaces of buildings against the formation of biofilms. This has proved to be an effective method. In the In the context of the preservation and restoration of cultural property, it has been demonstrated that these nanoparticles possess the capacity to self-clean, improve the surface of the material, function as a biocide to reduce the amount of biodeterioration, combine materials that have disintegrated, and improve the surface of the material.

At this point in time, a wide variety of items that hold significant cultural meaning are utilized in order to evaluate the effectiveness of these nanoparticles. The resources in question are what we refer to as "cultural heritage materials." The purpose of the research that Barberio M. and his colleagues carried out was to investigate whether or not it would be possible to use nanoparticles of silicon dioxide and titanium dioxide as strengthening materials. This research was conducted with the intention of determining whether or not clay-based items are capable of undergoing surface change, whether it be chemical,

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physical, or aesthetic manipulation. Following the treatment of the artifacts, it was observed that this layer possessed flawless transparency, homogeneity, and hydrophobic characteristics. Once the course of therapy had been completed, these characteristics were observed. The capacity of the nanoparticles to penetrate the artifacts' surface resulted in an increase in the surface resistance of the artifacts, which revealed another fascinating discovery. The effectiveness of nanoparticles that include silver, copper, zinc oxide, and titanium dioxide in the setting of wooden artifacts has been the subject of a significant number of studies that have been published. These nanoparticles have been found to considerably enhance the longevity of the wood and give protection against deterioration, as demonstrated by experiments conducted against termites, rot, mold, fungus, and UV degradation. Through the utilization of these nanoparticles, this has been demonstrated to be true. Several studies have shown that nanoparticles of zinc oxide (ZnO) and titanium dioxide ($TiO2$) possess antibacterial and antifungal activities that are both notable and promising. The manufacture of $Sr(OH)2$ nanoparticles was carried out by Ciliberto E. and those associated with him. After then, these nanoparticles were applied to a broad variety of cultural heritage pieces, including sculptures made of stone, wood, paper, and paintings, among other things. After the completion of the tests, it was shown that these nanoparticles have the potential to be utilized in an efficient manner for the consolidation and preservation of artifacts that are considered to be part of cultural heritage. It was only after the investigations were completed that this became apparent.

Furthermore, magnesium oxide nanoparticles were utilized in an additional experiment that was carried out with the purpose of efficiently deacidifying the paper and preventing the substance from deteriorating. The first demonstration of the utilization of hydroxyapatite (HAp) as an alternative to calcium oxalate for the consolidation of carbonate stones that are utilized in ancient constructions was carried out by Sassoni E. and colleagues, along with Ion R.-M. and colleagues. These individuals were the pioneers in this subject. Furthermore, due to the extraordinary compatibility of HAp with the crystal structure and lattice characteristics of calcite, it has been utilized in the consolidation of limestones, marbles, and chalk stone since its introduction. At this point in time, this is the case. As a result of its low viscosity, this aqueous consolidant product has the potential to permeate the stone to a rather deep level. The mechanical characteristics of the stone are significantly enhanced as a consequence of this penetration, which leads to the improvements. At first glance, metallic carbonated hydroxyapatite derivatives do not appear to be a viable alternative to the more typical consolidants that are currently being utilized. Figure 1 presents a visual representation of the current status of publications that are associated with the application of nanoparticles to a wide variety of different items. Due to the fact that it illustrates how diffusion has progressed over the course of time, this picture contains references to all of the nanoparticles that were utilized in the consolidation of those numerous artifacts.

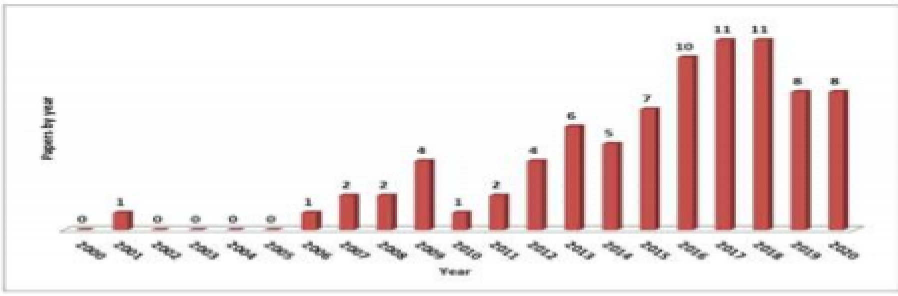

Figure 1. A graph showing the number of scientific publications published year between 2000 and 2020 about the usage of nanoparticles to combine various artefacts.

In an effort to improve the properties of materials that are used in consolidation, researchers have been looking for new materials ever since the turn of the century (Figure 2). When this viewpoint is taken into consideration, experts are particularly interested in nanotubes due to the numerous distinctive characteristics that they possess: Due to the tube's vast volume and open interior, it is possible to coat the inner surface of the tube with a wide variety of nanomaterials or agents. In addition, the surface porosity or form of the tube does not change over the pH ranges, which makes it resistant to the invasion of microorganisms and extremely resistant to the effects of mechanical and elastic stresses. There have been a number of studies that have been published recently that focus on the efficient utilization of tubular materials in the framework of art conservation processes. An further significant challenge that these tubular materials bring is the attachment of nanoparticles to the surface of nanotubes. The purpose of this endeavor is to investigate the possibility that nanotubes may be exploited to preserve or repair cultural treasures.

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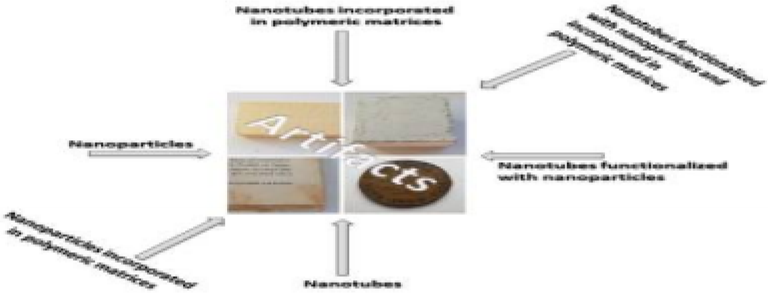

Figure 2. Nanomaterials that are utilized as consolidates in the process of preserving and restoring cultural heritage

Different classes of materials and substrates used for consolidation- Stone and wood are the two oldest building materials that are being used today for a wide variety of projects across the world. Stone and wood are commonly used in construction. In the beginning, these materials were utilized in the construction of a wide variety of buildings, including residences, churches, and other types of constructions. Later on, they were utilized in the production of a broad variety of decorative objects, like as instruments, furniture, and sculptures, among other things. Papermaking is still one of the most important use of wood that humanity have discovered over the course of human history. Due to the fact that it is an organic substance, wood is always susceptible to deterioration from a wide range of natural occurrences, including but not limited to heat, frost, the presence of several species, and so on. Wood from poplar, spruce, and lime are the three types of wood that are utilized in the manufacturing of artifacts in industrial settings the most frequently. There are a few aspects of the wood that have been demonstrated to exert an influence on its structural stability. Included in this category are extreme temperatures, which cause the wood to lose its structural integrity, biological assault, which causes the wood to become brittle and fragile, and excessively high humidity, which may have a negative impact on the substrate of the wood. Because of this, there is a great deal of brittle and damaged wood that has accumulated, which is a significant problem on a worldwide scale. Because of this, experts are attempting to create new materials and efficient techniques that will enable the production of wood that is durable for a long period of time. The goal of this form of treatment is to preserve the best possible level of authenticity that has been restored to the item while simultaneously enhancing the mechanical resistance of the material that has been deteriorated. In general, conservation treatments should adhere to criteria that are recognized globally. All of the following are included in these guidelines: The preservation treatment must not compromise the object's authenticity or integrity; it must be reversible and offer the opportunity for future restoration treatments when they are required; it must be stable for extended lengths of time; in addition, it must penetrate and spread uniformly throughout the surface of the wood.

As a part of their efforts to recover and preserve wood, researchers are conducting the analysis and experimentation of a broad variety of materials. The materials that fall within this group include Paraloid B44, B72, and B67, among others. Metallic nanoparticles and synthetic polymers are also included in this category of chemical substances. These synthetic polymers are utilized in two stages of the consolidation process simultaneously: the conditioning phase, in which the solvents evaporate and the solid polymer is connected in the wood structure, and the impregnation phase, in which the polymer solution penetrates the wood structure. Both of these phases are completed simultaneously. The process that is referred to as consolidation incorporates both of these steps within its overall method. Consolidation treatment procedures that are frequently employed include complete immersion, brushing, and spraying; however, the approach that is utilized must take into mind the specific features of the object that is being treated.

Jewelry, tools, weapons, sculptures, and architectural features are all examples of things that may be made out of stone, which is an inorganic substance that can be found in nature. Moreover, stones can be found in nature. Considering that these materials contain artifacts that date back between 700,000 and 130,000 years, it is possible that they hold the key to unlocking the first evidence of human activity. Basalt, granite, quartz, and diorite were the initial materials that were exploited in the construction process. The selection of these rocks was based on the fact that they possess an unusual level of hardness. Following this, the discovery of metals made it possible to work with any kind of rock and to produce works of art such as sculptures made of marble. In light of the fact that limestone and sandstone constitute the vast majority of building materials, a significant amount of focus has been directed into the investigation of methods for preserving and restoring these construction materials.

There are a number of events that have transpired over the course of time that have contributed to the impression that the stone's integrity is in jeopardy. The kind of weather, fluctuations in temperature, insufficient drainage of rainwater, incorrectly joined brickwork, and broken protective cornices are all examples of these factors.

When it comes to stone preservation, the most important considerations to take into account are the creation of a hydrophobic surface, the protection of the surface from impurities and the accumulation of both organic and inorganic particles, the guarantee that the treatment can be reversed, and the aesthetic compatibility of the treatment with the substrate. These days, there is a vast variety of technology that may assist with the preservation and restoration of stone. There are several examples of these technologies, some of which include hydrophobic coatings, antifouling treatments, and nanoparticles that clean themselves. Because of the written material that is associated with these components, they have been established. By including carbonated hydroxyapatite and its metal derivatives (silver, strontium, barium, potassium, and zinc), Ion R.-M. and his colleagues were able to improve the mechanical characteristics of stone models as well as their resistance to cold. This skill allowed them to achieve the highest possible level of resistance, which they were able to achieve. One of the reasons that this activity was carried out was with the intention of enhancing the stone's resistance to the freezing and thawing processes. Furthermore, the use of nano-HAp was shown to be effective when applied to specimens of marble and limestone. The use of HAp by Scherer G.W. to protect marble from the corrosion caused by acid rain resulted in a significant enhancement in the material's resistance to degradation. In addition, it is important to mention that Sassoni E. and colleagues investigated the appropriateness and efficiency of the HAp treatment for limestone in comparison to the ethyl silicate treatment. Silica has been shown to be an extremely promising byproduct of porous limestones that are employed as consolidants, according to the results of tests that have been done. It was able to circumvent a number of the weaknesses that are associated with ethyl silicate, such as those that are associated with compatibility and the extension of the curing period. In contrast to ethyl silicates, the HAp treatment was evaluated for its resistance to salt weathering, freezing and thawing cycles, and wetting and drying cycles. This was done in response to the findings of the same research. For the consolidation of limestone, it was demonstrated that HAp was a more effective alternative than ethyl silicates. This was demonstrated by the fact that the samples treated with HAp exhibited less deterioration than the samples treated with ethyl silicates after the consolidation process. For the purpose of contrasting the two types of silicates, an investigation was carried out.

Utilizing Nanomaterials for Preserving and Restoring Cultural Heritage- Mostly Utilized Nanomaterials- In recent years, nanoparticles have been put through a series of tests that have been successful in protecting architectural heritage. Specifically, this is due to the fact that damaged building components may be combined with nanoparticles and protected by them. The role that nanoparticles play in the process of repairing and preserving items is particularly significant. Although they cover the surface of the material, they provide a self-cleaning system that decreases the amount of pollution that is deposited and slows down the processes of external deterioration that are caused by dirt phenomena. All of this is accomplished while the treated portions retain their original appearance. These nanoparticles need to possess the following characteristics in order to be utilized in applications for the preservation and restoration of cultural heritage: a high capacity for absorbing solar radiation, a robust ability to adapt to the surrounding environment, thermal stability, chemical and biological inertness, and non-toxicity. At the moment, a wide range of nanomaterials, such as metal oxides (zinc and aluminum) and metal nanoparticles (gold, copper, and silver), are being utilized extensively for the purpose of preserving wood.

The wall of the wood has a porosity that is measured on a molecular scale. This is due to the fact that the pores that exist between the cellulose microfibrils in the wood are partially filled. Small nanoparticles have the potential to penetrate wood in a way that is both effective and comprehensive. This has the consequence of altering the surface chemistry and improving the qualities of the wood. Additionally, as long as the size of the nanoparticles is less than the diameter of the pores in the wood wall, it is possible to accomplish total penetration and uniform dispersion at the same time. According to reports, the internal structures of the wood are coated with a thin coating of TiO2 nanoparticles that are consistent in size and that have an average size of fifty nanometers. This coating helps to preserve the wood's natural appearance.

Mechanical and Physico-Chemical Properties- Over the course of the past decade, nanotechnologies have emerged as a significant player working within the realm of cultural heritage. The extraordinary features that they possess, which contribute to the preservation of items that are part of cultural heritage, are principally responsible for this. A few examples of these characteristics are the ability to prevent microorganisms from growing on surfaces, to shield materials from ultraviolet radiation, and to keep surfaces clean. It is possible to use nanoparticles for applications that require high efficacy while yet preserving the original material. In addition, nanoparticles have the potential to penetrate the structure of the material to a significant degree, with the extent of their penetration being primarily determined by the porosity and moisture content of the medium. One of the most significant advantages of using nanoparticles is this.

Titanium dioxide (TiO2) is an inorganic compound that can exist in the form of nanocrystals or nanogranules.

Because titanium dioxide may be employed in so many different ways, a significant amount of it is consumed. Over the course of the past few decades, this chemical has been utilized extensively as a pigment in a broad variety of items, including things like toothpaste, ointments, paintings, and UV protection as well. This material is ideal for a wide range of applications due to its numerous advantages, which include improved antibacterial activity and a very high surface area that is made possible by the extremely small particle size of titanium dioxide (TiO2). There is a close connection between these two characteristics and the dimensions, shapes, and crystalline structures of nanomaterials they possess.

There are a wide variety of processes that are utilized in the manufacturing of nanomaterials that are based on titanium dioxide (TiO2). Some of these techniques include the use of electrodeposition, direct oxidation, chemical vapour deposition, electrodeposition, and the sol-gel process. Other techniques include the hydrothermal process. Nanoparticles, nanofibers, and nanotubes are all possible forms of titanium dioxide that can be created, depending on the production technique that is utilized.

By a significant margin, the sol-gel method is the most widely used technology for the production of these nanomaterials. The hydrolysis and polymerization of the precursors in a standard sol-gel process results in the production of a sol, also known as a colloidal suspension, as the end product. Once the solvent has been entirely evaporated, the liquid sol can eventually transform into a solid gel phase during the polymerization step. This transformation can take place at any time. The hydrolysis of a titanium precursor using the sol-gel process results in the production of nanomaterials that are based on titanium dioxide (TiO2). Through the process of modifying the parameters of the reaction, Sugimoto T. and his colleagues were able to produce TiO2 nanoparticles that exhibited a comprehensive spectrum of sizes and forms. It was discovered that the form of the TiO2 nanoparticles changes from cubic to ellipsoidal when the pH of the solution is raised above 11 by adding the surfactant triethanolamine. This shift in shape occurred when the pH of the solution was elevated. It was demonstrated by the researchers that this is the case. It has been proven that the application of diethylenetriamine causes the form of TiO2 nanoparticles to develop into ellipsoids with a more pronounced appearance than that of triethanolamine. This occurred at pH levels that were greater than 9.5. The application of the two chemicals served as evidence that this was the case.

In addition, research that has been published in the scientific literature has demonstrated that the use of solutions containing sodium oleate and sodium stearate has the capability of altering the form of TiO2 nanoparticles from round to cubic. There is something intriguing about this change. The unique adsorption of shape regulators to these planes at different pH values is the source of the growth rate regulation of these crystalline planes of TiO2 nanoparticles, which in turn regulates shape control. This is the genesis of the growth rate regulation. What ultimately results in this regulation is the fact that form control is subject to such regulation. Particularly due to the fact that growth rate management is responsible for form control, this is the current situation. In a different experiment, the production of TiO2 nanoparticles by the use of the solgel method was investigated. Subsequently, the procedure of generating TiO2 nanocrystalline powders and assessing their photoluminescent features were done in connection to the affects of an acidic pH (3.2 to 6.8 in a hydrochloric acid solution). According to the data that was collected, the luminescence performance of TiO2 nanoparticles that were manufactured at a pH of 5.0 results in the best performance.

In an effort to conserve or repair historical and cultural relics, nanoparticles based on titanium dioxide are now being tested on a variety of different materials. For example, a series of studies were carried out in order to determine whether or not the application of TiO2 nanoparticles that were disseminated in an acrylic polymer solution was effective on some samples of marble and limestone. As a result of the findings of the research project, it was determined that titanium dioxide (TiO2) has a biocidal capability against the A. Niger fungus. This conclusion demonstrates that the procedure of growth suppression was relatively successful for both types of samples. The fact that the photodegradation investigations shown that it would be feasible to successfully accelerate the rate of oxidation of the methylene blue stains is certainly something that should be taken into consideration. There were distinct patterns that emerged over the course of time for the two distinct types of samples. In contrast, surfaces that are coated with limestone do not appear to be affected by sunlight, which suggests that the composition of the sample may have a significant role in the outcome for these surfaces. The coating on marble, on the other hand, has almost completely lost all of its value when it is allowed to age. In order to determine whether or whether these nanoparticles are successful as antifungal and biocidal treatments for woodworking, De Filpo G. and his colleagues conducted a one-of-a-kind experiment. Following the application of the treatment, the samples of wood were subjected to Hippocrea lixii and Mucor circinelloides, two bacteria that are known to hasten the breakdown of wood. In contrast to samples that were not treated, the findings indicate that the photocatalytic activity of TiO2 nanoparticles is capable of inhibiting the colonization of wood samples by fungus for a significantly longer period of time. This is the case when compared to

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samples that were not treated. In addition, this treatment was applied to the surfaces of the wood using an air pressure plasma jet, which resulted in an increase in the material's resistance to both ultraviolet (UV) radiation and moisture. A series of studies were conducted on coated and untreated wood specimens in order to determine the color changes that were produced by ultraviolet radiation. After being subjected to ultraviolet radiation, it was discovered that the sample that had been coated with titanium dioxide was more resistant to color change than the wood that had not been treated.

Zinc oxide, sometimes known as copper oxide, is an inorganic compound that finds use in a variety of industries, including the chemical, pharmaceutical, cosmetic, paint, and glass industries. Zinc oxide is one of the most widely used substances in these industries. There is a correlation between the size of ZnO particles and their antibacterial activity, and this activity may be increased by visible light. The ability of the composite to absorb ultraviolet light is another factor that contributes to the greater stability of the material. Only a few of the several methods that have been discovered so far for the synthesis of zinc oxide-based nanomaterials for usage in a variety of applications are the vapor phase growth, homogeneous precipitation, electrophoretic deposition, sol-gel, and vapor-liquid-solid processes. These are just a few examples. Adjustments to the solvent, pH, reaction temperature, and reaction time can be made in order to get the desired results of controlling the shape and crystallinity of ZnO nanoparticles. It is possible to alter the reaction time in order to do this.

Because of these features, there has been a rise in interest in studies pertaining to gold nanoparticles in a variety of fields, including the preservation and restoration of cultural assets. An instance of this would be the research that Ion R.M. and his colleagues conducted on samples of hazelnut wood in order to establish whether or not a unique method that used gold and hydroxyapatite (HAp) nanoparticles generated the effects that were anticipated. When compared to samples that were treated with either gold or HAp, or samples that were not treated at all (control samples), the findings demonstrated that the wood samples that were treated with the gold and HAp system were more stable and possessed superior mechanical and hydrophobic properties because of the combination of these two treatments. The situation was like this when the results were compared to the samples that served as controls. The presence of gold nanoparticles is the key factor responsible for these enhanced qualities. These nanoparticles have the potential to penetrate the channels of the wood and work their way through them, so becoming more durable and preserving the wood (refer to Figure 3). In addition, the application of the Au and HAp-based system to the sample led to the formation of a network of fibers on the surface of the wood, which resulted in a considerable increase in the surface hardness of the material. In contrast to the system that is based on HAp, this improvement includes.

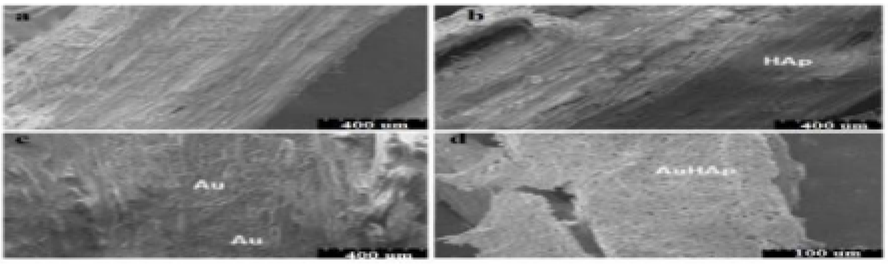

Figure 3. The accompanying SEM images display ancient wood, old wood treated with HAp, old wood treated with Au, and old wood treated with both Au and Hap. repurposed from a source that is open to the public.

nanoparticles of silver (Ag) and nanocomposites of these nanoparticles are among the nanomaterials that are utilized the most frequently. These nanoparticles are utilized in virtually every industry, including but not limited to the pharmaceutical industry, antibacterial agents, sensors, coating agents, catalysts, cosmetics, drinking water filtration, and a considerable number of other industries. Nanoparticles made of silver are the form of metallic nanoparticles that are utilized the most consistently. This is due to the fact that they were born with the specific physical, chemical, and biological features being present. In comparison to other noble metals, these nanoparticles have a number of advantages according to their physicochemical properties. The broad absorption of light, chemical stability, low acquisition costs, non-toxicity, high electrical and thermal conductivity, stability in the environment, and catalytic activity are some of the benefits that this material offers. There are now three different ways that may be used to manufacture silver nanoparticles: physical, chemical, and biological. Furthermore, they exhibit potent antimicrobial effect in a number of settings, including fungicidal and bactericidal activity, among other types of antimicrobial activity. In contrast, large-scale nanoparticles that possess desirable characteristics such as high yield, solubility, and stability may be created in a short amount of time and with little effort through the process of biological synthesis. Methods that involve physical and chemical processes, on the other hand, need the highest amount of effort. In the same way that the size and shape of gold nanoparticles have a substantial influence on their characteristics, the synthesis

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process also has a considerable impact on the properties of silver nanoparticles (which may be altered by altering the circumstances under which the reaction takes place). For instance, it has been demonstrated that the size of silver nanoparticles has a considerable impact on the bactericidal activity of these particles; the smaller the nanoparticle, the more effective it is.

OBJECTIVES-

1. One of the most researched methods is the sonochemical technique.
2. Surfactant approaches, electrochemical method, laser ablation, and sol-gel method.

MATERIALS AND METHODS- Fungi Isolation- Potato dextrose agar (PDA) was used as the substrate in order to produce pure cultures of the material that was obtained from the monuments. A delay of seven days occurred at the time of the discovery of colonies. According to reports, the National Centre of Fungal Taxonomy in Delhi is the body that is credited with discovering the fungus.

S.No	Name of fungi	Contribution, %
1	*The fungus known as Aspergillus flavus*	8.96
2	*F. fumigatus, A.*	12.37
3	*Niger or A.*	11.23
4	*It is scalrotium.*	7.82
5	*Temari, A. I.*	6.69
6	*Oxygenated Cladosporium*	7.82
7	*The clavata curvevularia*	6.69
8	*Spirulina clavata Curvularia*	5.55
9	*Fusarium sp.*	5.82
10	*Species of Mucor*	10.10
11	*White mycelia and sterile mycelia*	7.82
12	*This is Paecilomyces varioti.*	6.69
13	*Chrysogenum penicil compound*	8.96
14	*The genus Penicillium Sp.*	3.28

Elimination of Dust and Dirt Build-Up- As shown in Figure 4b, the Archaeological Survey of India took measures to strengthen and safeguard the stone by giving it a gentle washing and removing any debris or dust that had accumulated on it. These actions were taken in order to strengthen and maintain the stone. For the purpose of preserving the stone's pH balance, this action was taken. It was possible to get rid of the moss, fungus, and lichen by employing a nylon brush and an ammonia solution in water that was two to three percent. Due to the fact that the stone had been punctured by the micro-vegetational growth to such a degree, only a superficial cleaning with an ammoniacal solution and soft nylon brushes had been carried out. After the thick covering of moss, fungus, and lichens was removed and washed away with a solution of oxalic acid in diluted water, this resulted in the production of black regions of residual microvegetational deposits. This was the result of the removal and washing techniques. The surface was next treated with a diluted combination of liquid ammonia and non-ionic detergent (Fig. 3b), which was applied after the chemical treatment had already been completed. The purpose of this action was to eliminate any residue that could have been there, which may have included dust, ammonia, and acid. In order to inhibit the formation of microvegetation, the surface was first carefully cleaned and then dried before being treated with an aqueous solution that included 2% sodium pentachlorophenate. Both the brittleness and the powdery texture of the stones were preserved by the coating substance that was based on ethyl silicate despite being applied to them. Both brushing and saturation impregnation were utilized in order to accomplish this. Additionally, the evaporation process results in the production of ethanol as a byproduct, in addition to the production of a silica gel binder that has the appearance of glass (SiO_2 aq.). It is important to note that the production of stone strengtheners needed a much greater quantity of resources when using damaged and ground-up stones (Fig. 2b). Taking this into consideration is something that is necessary. To put this into perspective, we may argue that there are more pores that are just waiting to be opened or opened. Stone strengthener was applied to the surface of the cracked and flaky stone by simply brushing it on and increasing the amount of impregnation until the stone was completely saturated.

Fig. 2. The Sita Devi Temple's precise layout is as follows: a) before to consolidation; b) following consolidation

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Solutions for Preservation- That the preservation solution that is being applied to the monuments is of the best possible quality is something that needs to be guaranteed. The substance in question should be transparent and devoid of any color, and as it matures, it should not become yellow or acquire any coloration. On the other hand, it need to maintain a high level of stability over a considerable amount of time. To protect the surface of the stone from deposits that are deteriorating, the coating must be sufficiently durable and robust enough to survive for adequate time. Additionally, it should offer the monument the crucial protection from moisture that it requires. As a consequence of this, Wacker BS-290, a chemical that is composed of silane and siloxane, was chosen in order to protect the Sita Devi temple. After being diluted with mineral turpentine oil at a ratio of 1:16, it was then applied to the monument using a painting brush that was handled with extreme consideration. When MTO is employed as a solvent, there is a momentary, minute darkening that takes place; nevertheless, as time passes, the evaporation of the solvent slows down, and the surface that has been preserved recovers to its initial state. Due to the fact that this combination is waterproof, it prevents water from accumulating on the surface of the stone.

RESULTS AND DISCUSSIONS- During the course of the current investigation, it was discovered that fifteen different types of fungal flora were accountable for the deterioration of the monument (Tables 1 and 2). It was discovered that there were a great number of fungal species, including Muco, Trichoderma, Penicillium, Mycelia sterilia, Aspergillus, and Fusarium species. The conclusions of the current examination are in line with the findings of other investigations that have been carried out by academics in the past. In their 2008 study, Alka Jain and colleagues proved that the presence of an excessive amount of moisture in building materials may be conducive to the growth of microbes. According to the findings of a study that was conducted by Bungartz and his colleagues, the growth of endolithic lichen and fungus may be utilized to properly determine the manner in which these organisms have ecophysiologically adapted to the harsh environment of the rock. There is a significant amount of variation in the variety of the soil crust biota across different geographical areas, particularly with regard to the quantity of cyanobacteria, algae, and fungus. To add insult to injury, the evaluation of these animals is seldom dependent on material that was created.

CONCLUSION- The preservation of cultural assets on a worldwide scale has been an increasingly important topic of discussion over the course of the last several decades. First and foremost, this is due to the fact that it is of the utmost importance to safeguard not only the history of humanity but also the genuineness of different structures and artifacts. Items like as ceramic containers, stone tools, wooden tools and objects, metal or personal ornamentation, and other items of a similar kind are examples of the kinds of things that are considered to be classic artifacts. The structural integrity of these objects is significantly impacted by the features of age and external degradation that are evident on the surfaces of these items. As an illustration, the mechanical strength and structural integrity of wood products are greatly damaged by a wide variety of severe degrading processes that occur on a regular basis. As an example of one of these processes, the breakdown of chemical or biological components should be considered. Because of their ability to merge and preserve architectural features that have been destroyed, nanoparticles are now giving a practical solution to the problem of cultural heritage. In order for nanomaterials to be taken into consideration in the planning process for the preservation and restoration of cultural assets, the following standards must be established and satisfied.

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