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Nano Coating Start-ups Opportunities in India – A Review

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Abstract: Nano Coatings are nanotechnology-based coatings with very fine, thin layers of nano particles that are used to impart specific chemical and physical characteristics to a substrate surface .Nano coatings can easily be adopted for several uses .The future of the global nano coating market looks promising with opportunities in industries such as food preservation, metal coating, textile industries, etc., The market is further expected to reach a figure of US$ 13.5 Billion by 2023, exhibiting a CAGR (Compound Annual Growth Rate) of 20.6% during 2018-2023.Increasing demand for nanotechnology in emerging countries, including China, Japan and India, supports the growth of the nano - coating market in Asia Pacific. Increase in commercial and government investment in sectors such as automotive, infrastructure, shipping port projects and general manufacturing is growing rapidly Indian government is providing various start-up funds to encourage entrepreneur. This article deals with advance materials technology in the current era of Industry 4.0 which has huge scope for business opportunities in all kind of new innovators in nano coatings.

Keywords: Nanotechnology, Nano coating, Start-ups.

1. Introduction

Nanocoating refers to nanoscale thin-films that are applied to surfaces in order create or improve a material property such as corrosion protection, friction reduction, antifouling and antibacterial properties and self-cleaning. It provides a significant part in various fields like marine, aerospace, defence, medical, marine etc., by producing the multi-functional coated products. Nano coatings is becoming trending technology because conventional coatings have some limitations such as (i) improper adhesion between coating layer and substrate, (ii) strength loss, (iii) less flexibility, (iv) less durability and (v) poor abrasion resistance. These issues of conventional coatings can be solved by nanocoating's. [1] Nano coating are emerging in the application of Anti-corrosion, water proof and non-sticking element, Anti-bacterial, anti-abrasion, self-healing, anti-reflection and anti-icing [2].

Due to extensive application in nano coating field there are lots of business

opportunities for establishing the nano coating concepts in the current era of Industry 4.0. To develop the ideas through the field of nano coating there are lots of start-up opportunities provided by the Indian government for flourishing the new innovation and entrepreneurship.

2. Application of Nano Coating

Nan coating is a developing field and some of its applications are already in use whereas many other applications with great potential are under research. Few of nano coating applications are summarised below.

Anti-corrosion is the phenomenon of protecting the metallic and non-metallic surface from being corroded to the environmental condition. The nano coating creates the bonding between the nano particles and material surface [3]. Antibacterial coating helps the surfaces to reduce the growth of microorganisms. This has considered as popular area of nano coating applications. Antibacterial coatings can also play an essential role in many serious threats due to infectious disease in public threat [4]. Thermal barrier coatings are mainly applied to metallic surfaces that operate at elevated temperatures [5]. These coatings are applied in the field of gas turbines, turbo chargers etc., The nano particles used in these applications are alumina, silica, ceria. Abrasion is the process of wearing down by means of friction. Abrasive resistant coatings can be used in certain environments unsuitable for lubrications. These coatings help the material for long lasting and better performance. The common material used for abrasive resistant coatings are chrome carbide, chrome oxide, tungsten carbide. Self-healing coating possess the internal capability to repair sustained damage by themselves or other external stimulation. Some popular application incorporating self-healing coatings in the market can be found in the mobile phones, automotive and decorative paint markets. Anti-reflective coatings are used to increase the lens transmission. Anti-reflection coatings are mainly used in optical products like eye-wear, and improving the efficiency of solar panels [1]. Anti-graffiti coatings are invisible to the naked eyes and are available in two methods. In first method coating can be peeled off once graffiti has been applied on surface and the second one in which the coating is coated on the surface preventing the adhering of surface.

3. Business Opportunities in Nano Coating

The future of the Global nano coating market is increasing and showing positive signs with many upcoming opportunities in construction, automobile, electronics, marine, energy etc., Global manufacturing and commercial institutions are moving towards nanocoating technologies to further improve the current commercial products or add new properties to the existing technologies completely. Construction, glass, solar, oil & gas, automotive organizations recognize that nano composites-base coating offers substantial performance of product and also saves cost [5]**.** The global nanocoating market is expected to reach an estimated $15.8 billion by 2023 and it is forecast to grow at a CAGR of 22.8% from 2018 to 2022. The superior functional properties and emerging trends are the major drivers of this market, which have a direct impact on the dynamics of the nanocoating industry, include nanostructure coating for prevention of bio film-associated infections on medical devices and the development of nanocoating for waterproof mobile devices.

4. Nano Coating Applications

Nano coatings provide a significant part in various fields like marine, aerospace, defence, medical, marine etc., by producing the

multi-functional coated products. Few of the nano technology applications are discussed in detail and also about the business opportunity are discussed.

4.1 Nano coating application in food industry

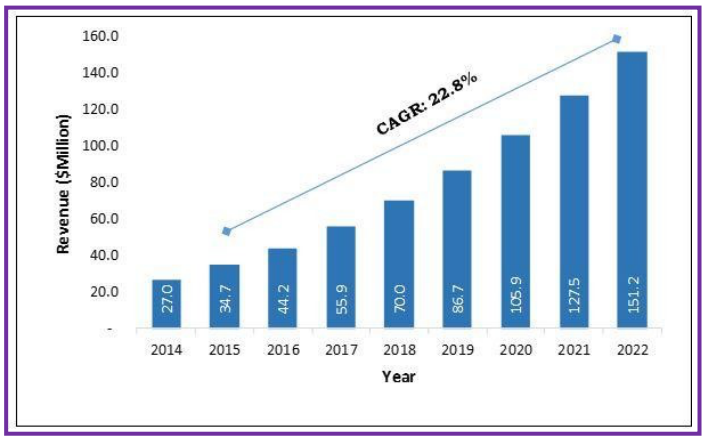
Nano coatings are applied on the fields such as food contact food packing and texture food. Various edible nano coatings can be developed at a size around 5 nm. These edible nano coatings has wide range of applications like meats, fruits and vegetables, confectionery, cheese, and fast food. They provide an barrier against the moisture and gas exchange to deliver flavours, antioxidants, enzymes and anti-browning agents. This increase the shelf life of manufact

Nano coating in food sectors are used in the field of nano coatings on food contact, food packaging, nano structured texture food. Enables the development of nanoscale edible coatings as thin as 5 n Edible nanocoatings is used in the application of meats, cheese, fruit and vegetables, confectionery, bakery goods, and fast food providing a barrier to moisture and gas exchange, to deliver colours, flavours, antioxidants, enzymes and anti-browning agents. This increase the shelf life of manufactured foods, even after the packaging is opened [6]. The properties of mango puree edible films can be much improved through cellulose nanofibre's reinforcement [7].

An edible antibacterial nanocoating can be applied directly to bakery products. [8]. The usage of antimicrobials such as silver or titanium dioxide nanoparticles can prevent spoilage of food. Nanotechnology can be used in plastic food packaging to make it stronger, lighter and for better performance foods. It is predictable that widespread adoption of Nano-agriculture in the future would be a break through especially for agricultural country like India [9].

4.2 Nano coating in wood industry

Wood has been used for thousands of years, for several reasons. It is rich and economical, available in many species, and people find its appearance interesting. It is still one of the primary materialsin building constructions because of durability and high strength. Wood can be used for both outdoor and indoor applications. Wood is most often protected with coatings that prolong durability by protecting the substrate in outdoor conditions like UV light, high humidity, mechanical damage, chemicals, living organisms like fungi, termites, etc. Coatings can also further improve durability by providing suitable nano material in coating [10]. Some of the nano particles used for coatings in metals are (silver, gold, copper etc.,) metal oxides nano particles such as (zinc oxide, aluminium oxide) are widely used in the application of wood nano coating. [11, 12].



Wood nano coating also prevents the growth of microorganisms; hence it also acts as an anti-bacterial coating. Some of the nano particles such as silver and copper [13]. When talking about usage of these types of materials in coatings, slow, controlled release of the active ingredient is important because of its prolonged positive effect and lesser environmental impact. Because of the ordered platelet structure together with interlayer captions that can be exchanged, claysarecapable of controlling her release of different protective agents [14, 15] andMalachovaetal. [16] Have shown that this is also possible with ions of silver and copper.

4.3Nano coating in bone repair

Currently, musculoskeletal maladies are the main reasons for the disability and associated diseases around the globe [17]. The bone fracture, osteoporosis, and various neoplastic maladies are the most common clinical problems associated with bone and skeletal system. These common problems may be associated with malnutrition, aging, hormonal imbalance or trauma. It is estimated that around 2.2 million bone tissue graft transplants are performed all around the globe annually [18]. The auto graft is common orthopaedic implant but has certain well documented limitations [19, 20]. After 10–15 years on average, the traditional implant failure is associated with biomaterial associated inflammation, loosening, wear or tear debris, osteolysis and autoimmune reactions.[21]. Biomedical applications of the nanoscale materials in bone and supporting tissues, are highly appreciated in modern therapeutics and surgery. The 3D scaffold, structural analogy, biocompatibility, growth promoting properties, and time-bound degradability of nanoscale materials make them ideal candidates for orthopaedic prosthetic surgeries and bone reparation [17]. Biocompatibility is the ability of a material to work efficiently with an appropriate host response in septic applications [22]. Strong evidence of anti-infective efficiency is the anti-bacterial efficiency should be demonstrated, in vivo and also in an appropriate model of PJI [23–25]. Mechanical characteristics of the antibacterial coating is resistance to mechanical stresses and strains either during surgery or postoperatively [26]. A number of principles from basic research have been proposed for translation into technologies potentially suitable for antibacterial treatment of orthopaedic implants [27].

4.4 Nano coating in textile

Innovations from leading nano coating manufacturers have created unique solutions that have completely transformed textiles and nonwovens, introducing fabrics with brand new properties. The application of nanotechnology in textile manufacturing has led to the introduction of fabrics with excellent chemical resistance, mechanical strength, water repellence, antibacterial properties, and other properties that cannot be achieved by other means. In conventional methods, such as dip coating, nano colloidal has been used in coating process [28], while the wide ranges of coating methods have been promoted [29- 31]. In present, preparation techniques of water repellent fabrics have several methods such as coating with paraffin wax, treating fibre surface with pyridinium compounds, silicone resin or fluorocarbon. At present, fluorochemicals are used widely due to their higher water repellence [32, 33]. Typically, the water contact angles between 120° and 130° are obtainable with treatment using the fluorochemicals. Surface hydrophobicity modification using sol-gel method has been introduced as an alternative approach [34, 35]. The nano materials used for the purpose of textiles are Silver, Zinc oxide, silicon dioxide, titanium dioxide.

4.5 Nano coating in marine

Marine bio fouling is caused by the adhesion of barnacles, microalgae, and

microbial slimes. It is a worldwide problem in marine systems. This natural process has heavy negative economic impacts: increase in fuel consumption for ships and in maintenance costs for Mari culture equipment's pipes and offshore and harbour constructions. [36] Antifouling coatings are used to increase the speed and energy efficiency of ships by preventing organisms, such as barnacles and weed, building up on the underwater hull and helping the ships movement through the water. Low surface energy, non-stick coating is expected to prevent the adhesion of fouling organisms by providing a low-friction, non-wetness surface, on which organisms have great difficulties in settling. It is a friendly coating without releasing toxic materials, thus much work has been done to elucidate the properties that a coating should possess to resist adhesion [37-41]. Generally, when the surface energy is less than the25 mJ·m−2, adhesion of bio fouling can be prevented [42]. The efficiency of photoactive materials, such as TiO2 , is largely limited by the intensity of incident radiation. The absorbance of TiO2 lies predominantly in the UV region, and hence researchers are working on the production of TiO2 doped with other substances such as platinum, silver, copper or nitrogen to improve its efficiency in the visible region. [43] Silver has been widely used for its bactericidal activity [44]. Silver and its compounds have widespread uses in a number of applications including wound dressings,[45] the treatment of burns, medical devices and catheters, [46, 47] and textiles. Silver nanoparticles have also been shown to be strongly bactericidal [48]. Antimicrobial silver ions or nanoparticles have been grown or embedded in polyamides, [49-51] polyelectrolyte multilayers, fibreglass, and other polymers, as well as in hydrogels, to form antimicrobial films.

4.6 Nano coating in teeth

Dental caries represents a very common disease, and are often due to bacteria adhesion, such as that of Streptococcus mutants, and subsequent biofilm formation. As reminded by Helfman, these bacteria, in the presence of sugars or fermentable carbohydrates, generate acids such as lactic, prop ionic, or acetic acid, which will attack the tooth enamel and cause tooth decay. In this respect, a strategy to annihilate or at least limit tooth decay is to develop antibiofouling biomaterials applied onto the teeth. These biomaterials used in dental protection can either kill or prevent bacteria adhesion. In the first case, biomaterials possess an antibacterial activity. This function can be attributed to, for example, the introduction of quaternary ammonium salts, or coating of a metal. Shed and co-workers reported recently on the use of Zno and Cu coated on teeth model by sonochemical irradiation.2 They managed to uniformly deposit metal coatings onto the surface of artificial teeth, resulting in a decreasing of biofilm formation of at least 70%, compared to uncoated tooth. In the second strategy, an increase in hydrophilic moieties prevents possible interactions between teeth material and proteins. Indeed, as repeated by Muller et al. (2010), the pellicle, a thin, invisible, bacteria-free protein film, is adsorbed in the oral cavity.6 It acts as a protective laver against friction, but also favours bacteria adhesion, which outer cells are made of rather hydrophobic proteins. Attachment of bacteria can be prevented by coating various types of hydrophilic materials onto the tooth, including neutral, positively- or negatively charged molecules, and zwitterions [52]. Enamel, the exterior coating of vertebrate teeth, is a bio mineral. It has remarkable hardness and resistance to physical and biochemical attack. The special features of enamel result from its composite nature, asitiscomposedof substituted hydroxyl apatite, and organic macromolecules. The tissue is assembled of needle-like crystals, bundled in parallel ordered prisms, but the exact microcrystalline alignment is specific to each individual. Currently, defects in enamelandthe

underlying dentine are usually refilled with unstructured substitutes like amalgam, ceramics, or polymer composites to prevent tooth death. Various attempts to harden enamel surfaces or remineralize tooth minerals have been undertaken, which include treatment with fluoride, met stable calcium phosphate solution, or apatite particles. Conditioning with apatite–protein composite nanoparticles leads to mineral depositions on dentine surfaces.

5. Innovation and Entrepreneurship development in India

The Government of India has undertaken several initiatives and instituted policy measures to foster a culture of innovation and entrepreneurship in the country. Job creation is a foremost challenge facing India. In the recent years, a wide spectrum of new programmes and opportunities to nurture innovation has been created by the Government of India across a number of sectors. Recognising the importance of women entrepreneurship and economic participation in enabling the country's growth and prosperity, Government of India has ensured that all policy initiatives are geared towards enabling equal opportunity for women.

Start-up India:

Through the Start-up India initiative, Government of India promotes entrepreneurship by mentoring, nurturing and facilitating start-ups throughout their life cycle. Since its launch in January 2016, the initiative has successfully given a head start to numerous aspiring entrepreneurs.

Make in India:

Designed to transform India into a global design and manufacturing hub, the Make in India initiative was launched in September 2014. It came as a powerful call to India's citizens and business leaders, and an invitation to potential partners and investors around the world to overhaul out-dated processes and policies, and centralize information about opportunities in India's manufacturing sector.

6. Conclusion

Nano coatings offer a wide range of business opportunities with the growing technology. India has been a supporting entrepreneurship devolvement with the availability of resource and financial assistance.

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