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Nanocoating : A Novel Drift in Nanotechnology

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***Abstract* – In this paper the elementary inkling of nanocoating is deliberated along with its conceivable present and future applications. By using nanotechnology, materials can effectively be made to be stronger, lighter, more durable. Recent attention focuses on nano composite materials and coatings. The nano materials and their corresponding nanocoating usage are mentioned briefly. Some nanocoating techniques such as Waterproof nanocoating, Electrostatic layer-by-layer nanocoating, Anti-graffiti and Sol-gel nanocoating, Anti-mist nanocoating, UV and IR protection nanocoating, Anti-glare nanocoating, are pronounced with their promising applications.**

***Keywords* – Nanocoating, Nano Materials, Nano Technology, Nano Scale.**

I. Introduction

In present scenario the nanotechnology has been encompassed in numerous dimensions of our life in different evolved forms. One of these advanced forms is nanocoating. When trying to clench the use of nano in coatings, we should note that sometimes the components in the coating are nano but the coating is not nano in nature. And sometimes the coating construction is itself nano in nature. The second is rarely used and is principally constrained to use in the electronics field. The previous is used at large scale in practical. In general, nanocoatings can be anti-graffiti, anti-static, anti-mist or anti-glare or they can prevent UV light while permitting visible light through or coat medical devices to assist neutralize the refutation in the body. The nanocoatings that contain nanoparticles can be used to overhaul worn out parts on ships. Metal nanoparticles are being used in the electronics industry to coat the surfaces of capacitors. A coating made from nano titanium dioxide can make glass change color when exposed to light or ensure that dirt on glass windows just washes away with the rain. The nanocoating is done with the help of nanomaterials.

II. Nanocoating

Nanocoating is the procedure of covering a material with the help of a film on the nanometer scale or to shield a nanoscaled body. Nanocoating forms a nano combination that involves an arrangement of two or more different substances of nanometer size, thus producing a material that usually has discriminating or instantly recognizable targeted properties, due to the combined properties and structuring properties of the components. Different methodologies have been reconnoitred to manufacture such structures including vapour deposition, chemical reduction, pulsed laser deposition, mechanical milling, and electrochemical deposition etc. Few available nanomaterials and their properties in coatings are enumerated here.

- Copper Oxide-Anti-microbial
- Silicon Dioxide-Mechanical properties
- Cerium Oxide-UV / light –stability
- Iron Oxide-UV / light –stability and Magnetism
- Aluminum Oxide- Mechanical properties
- Zinc Oxide-UV / light –stability and Anti-microbial
- Indium / Antimony Tin Oxide- IR-absorption
- Titanium Dioxide-UV / light –Anti-microbial

A. Electrostatic Layer-by-Layer Nanocoating

In the pharmaceutical field coating is often used to alter and heighten the performance of drug delivery systems. Customary coatings comprise film and sugar coatings. Now contemporary improvements in the field of nanocoating are correspondingly applied in drug conveyance. In general there are two types of nanocoatings [1, 2]. One of them is metallic nanoshells composed of a dielectric core (for example, silica) that is coated with an ultra-thin metallic (for example, gold) layer and another one is nano-thick coating formed by electrostatic layer-by-layer molecular self-assembling. Two of them nanocoatings characteristically possess a tiny core (empty or filled) that is wrapped in an exterior hedge of nanometer thickness. Layer-by-layer nanoassembly is centered on the sequential adsorption of positively and negatively charged polymers on a surface to form a nano-thick film of coating. The process involves resaturation of polyion adsorption, resulting in the reversal of the terminal surface charge of the film after deposition of each layer [4]. The technique affords the probability of designing ultrathin multilayer films with meticulousness better than one nanometer of defined molecular composition. These films can be applied to surfaces or can be used to coat micro and nanoparticles. This coating process can be used to control the release of drugs, increase the stability of drugs and to improve the properties of commonly used excipients. Since no covalent binding is involved in the shell formation it allows the drug or excipient to remain intact.

Layer-by-layer self-assembly systems are very encouraging and could arrange for a very robust platform to create innovative, hybrid or alleviated drug delivery systems for a myriad of drugs and genes. The technology can be employed on various nano to macroscopically sized systems [3]. Due to the technology's ease and charge of preparation, circumvention of hazardous preparative chemicals, independence of specific stoichiometry, facilitation of controlled, triggered and target release, the technique should see substantial development in the future as a leading drug delivery technology. Concurrently to developments in drug delivery, layer-by-layer nano-coatings has also found numerous applications in improving the stability and processing of drug solids and excipients.

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B. Anti-mist Nanocoating

Nanocoating could eradicate foggy windows and lenses. Researchers have been developing anti-fog technology for years, but each methodology has its drawbacks. Some provisions carry special anti-fog sprays that help reduce fogging on the inside of car windows, but the sprays must be constantly reapplied to remain effective. Glass containing titanium dioxide also shows potential for decreased fogging, but the technique only works in the existence of ultraviolet (UV) light. Now, a group of scientists have found a long-lasting elucidation to the problem. A distinctive polymer coating have been established, which is made of silica nanoparticles and can create surfaces that never fog. These transparent coating can be applied to eyeglasses, camera lenses, ski goggles, bathroom mirrors. Coated glass seems clearer and permits more light to pass through than untreated glass while maintaining the identical smooth texture. The coatings comprise of alternating layers of silica nanoparticles, which are basically tiny particles of glass, and a polymer called polyallylamine hydrochloride, both of which are relatively cheap to manufacture.

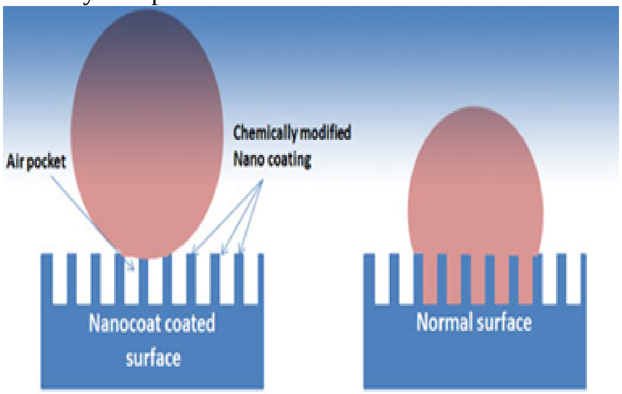

Fig.1. Anti-mist nanocoating surface and normal surface.

When fogging take place, thousands of miniature water droplets condense on glass and other surfaces. The droplets scatter light in random patterns, causing the surfaces to become translucent or foggy. This often occurs when a cold surface suddenly comes into contact with warm, moist air. The new coating precludes this process from occurring, primarily through its super-hydrophilic, or water-loving, nature. The nanoparticles in the coating powerfully fascinate the water droplets and force them to form much smaller contact angles with the surface. As a result, the droplets flatten and merge into a uniform, transparent sheet rather than forming countless individual light-scattering spheres. "The coating basically causes water that hits the surfaces to develop a sustained sheeting effect, and that prevents fogging".

C. UV and IR Protection Nano Coating

In few available UV heat protectors, UV heat protection is done by using almost a 100-µm thick transparent self-adhesive polyethyleneterephtalate (PET) foil with 12.5-µm thick transparent (having transparency > 80%) nano coating which can reflect and absorb the sun's ray and keep out the heat. It is practically found that temperature of sealed box using such available UV heat protector on the front glass window remains at 27.3 degree Celcius while the adjacent box without UV heat protector is heated above 27.3 degree Celcius by the same light source. Nanoparticles distributed in the substrate materials are smaller than the wavelength of the light and so it is invisible. The utilized functional nanoparticle (~25 nm) coating is transparent and shows excellent infrared (IR) absorption. It also has an supplementary advantage that the coating surfaces won't become misty by the condensation of water from the cooled air because IR absorption automatically heating up the coating surfaces. Self-adhesive UV heat protector has widely been used for the heat protection of greenhouses, sun parlors, glass facades and roofs in industrial buildings. In addition to the IR-heat protection films, thermal heating foils and flexible thin film solar cells are developed using nano coating technology. The nanostructures in the heating foils lead to surplus advantage of high electrical conductivity and thus low power consumption. Heating foils can be applied at residence, bathroom & sanitary, automotive, camping, leisure and other industrial heating applications.

A. Waterproof Nanocoating

In waterproof nano coating a nanometer-thin coating is applied to a device as a gas, permitting it to infiltrate inside the covering and fend off liquids. Basically nano coating is applied with a vapour process in a vacuum.

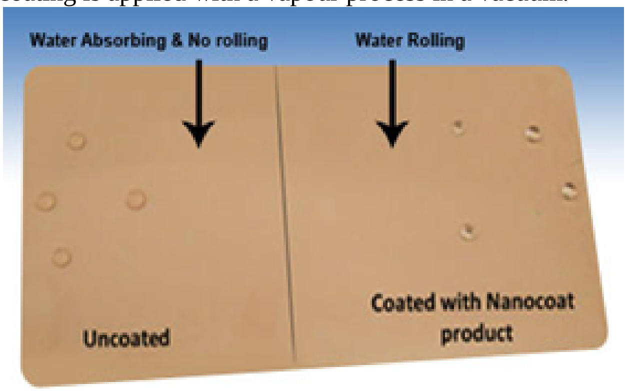

Fig.2. Uncoated surface and Water proof nanocoating surface

There are innumerable methods to creat the waterproof nano coating. In one of the methods it is a chemical vapor deposition that mantles vital electronic circuitry with a nano-thin film containing highly effective, water-repelling characteristics. Another scheme engages a special pulsed ionized gas (plasma), which is produced inside a vacuum compartment, to attribute a nanometre-thin polymer film over the entire surface of a product. This procedure radically diminishes the surface energy of a product, so that when liquids come into interaction with it, they form beads and basically run off.

D. Anti-graffiti Nanocoating

An anti-graffiti coating is a covering that precludes graffiti paint from sticking to surfaces. Anti-graffiti coatings can be undistinguishable to the naked eye creating them perfect for maintaining historic structures.

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There are two diverse classifications of anti-graffiti coatings. The first, sacrificial coatings, are applied to a surface and then detached when graffiti is applied. The surface beneath will be left clean and a new sacrificial coating can be applied. The other type of coating are stable coatings that prevent graffiti from adhering to a exterior in the first place. Fresher coatings are made of charged polymeric materials that form a gel on the surface of the construction or substrate. Some of the most significant individualities of anti-graffiti coatings are-

- Sufficient adherence without damage to buildings
- Hydrophobicity (water-repellance)
- Environmentally friendly composition
- Resistance to UV aging and weathering
- Good Cleaning Efficiency

Stable nanocoating effort by creating a protective surface that spray paint cannot bond to. After the surface has been vandalized, often all that is needed to remove the paint is a simple solvent (toluene) and some manual labor. The underlying surface and the protective coating will remain undamaged.

E. Sol-gel Nanocoating

The sol-gel procedure is a wimpish-chemical method extensively applied in the different arenas of materials science and in the field of engineering. Such methods are used primarily for the fabrication of materials (typically metal oxides) starting from a colloidal solution called sol that acts as the precursor for an integrated system or gel of either distinct elements or network polymers [5, 6]. Typical precursors are metal alkoxides and metal salts (such as chlorides, nitrates and acetates), which undergo various forms of hydrolysis and polycondensation reactions.

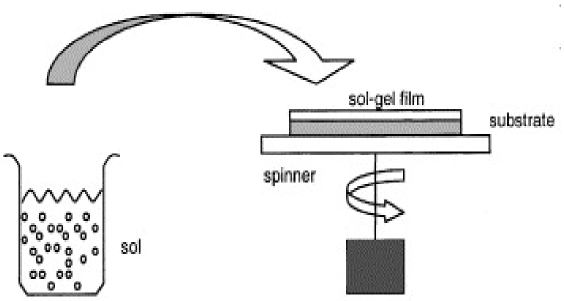

Fig.3. Sol-gel formation process [13]

Sol-gel nanocoating in solution is normally performed utilizing either predecessor molecules or preformed particles to creat the layer [7,8]. The sol-gel procedure encompasses inorganic predecessors (a metal salt or organometallic molecule) that go through various chemical reactions causing in the creation of a three-dimensional molecular system [9,10]. One of the most general paths is via hydrolysis and condensation reactions of metal alkoxides to creat larger metal oxide molecules that polymerise into a coating entity. The sol-gel technique permits coating of substrates with compound forms on the micrometer to nanometer scale, which some generally used coating procedures cannot achieve [12].

III. Conclusion

Since there is still some future work and development is in ongoing state in nanocoating technique. Therefore in this paper some present and some possible future usage of nanocoating techniques are mentioned. Every methodology has few limitations also. In the case of nanocoating technique, its effects on human health and on environment are yet to be declared. Till date nanocoating has proved itself as a worthwhile technology in various fields including almost every dimension of our life.

References

[1] G.B. Sukhorukov, H. Möhwald, G. Decher, Y.M. Lvov, *Assembly of polyelectrolyte films by consecutively alternating adsorption of polynucleotides and polycations*, Thin Solid Films, 284-285 (1996) 220-223.

[2] M.M. de Villiers, D.P. Otto, S.J. Strydom, Y.M. Lvov, 'Introduction to nanocoatings produced by layer-by-layer (LbL) self-assembly.' Adv, Drug Deliv. Rev. iews.

[3] H. Ai, S.A. Jones, M.M. de Villiers, Y.M. Lvov, '*Nano-encapsulation of furosemide microcrystal for controlled release*', J. Controlled Release. 86 (2003) 59-68.

[4] N. Pargaonkar, Y.M. Lvov, N. Li, J.H. Steenekamp, M.M. de Villiers, '*Controlled release of dexamthasone from microcapsules produced by polyelectrolyte layer-by-layer nanoassembly*', Pharm. Res. 22 (2005) 826-835.

[5] E. Matijevic, *Fine Particle Science and Technology*, M. Pelizetti, Kluwer, Dordrecht: The Netherlands, 1996.

[6] L.M. Liz-Marzan, M. Giersig, P. Mulvaney, '*Synthesis of Nanosized Gold−Silica Core−Shell Particles*', Langmuir, vol. 12(18), pp. 4329-4335, 1996.

[7] M. Ocana, W. Hsu, E. Matjevic, 'Preparation and properties of uniform-coated colloidal particles. 6. Titania on zinc oxide', Langmuir, vol. 7(12), pp. 2911-2916, 1991.

[8] F. Caruso, 'Nanoengineering of Particle Surfaces', Adv. Mater., vol. 13(1), pp. 11-22, 2001.

[9] R.A. Caruso, M. Antonietti '*Sol−Gel Nanocoating: An Approach to the Preparation of Structured Materials*', Chem. Mater., vol. 13(10), pp. 3272-3282, 2001.

[10] E. Mine, A. Yamada, Y. Kobayashi, M. Konno, L.M. Liz-Marzan, '*Direct coating of gold nanoparticles with silica by a seeded polymerization technique*', J. Colloid. Interface Sci., vol. 264(2), pp. 385-390, 2003.

[11] Y. Kobayashi, H. Katakami, E. Mine, D. Nagao, M. Konno, '*Silica coating of silver nanoparticles using a modified Stöber method*', J. Colloid. Interface Sci., vol. 283(2), pp. 392-396, 2005.

[12] A.P. Philipse, A.M. Nechifor, C. Patmamanoharan, '*Isotropic and Birefringent Dispersions of Surface Modified Silica Rods with a Boehmite-Needle Core*', Langmuir, vol. 10(12), pp. 4451-4458, 1994.

[13] K Galatsis, Y.X Li, W Wlodarski, K. Kalantar-zadeh, '*Sol–gel prepared MoO3–WO3 thin-films for O2 gas sensing*', Sensors and Actuators B: Chemical, Volume 77, Issues 1–2, 15 June 2001, Pages 478–483.

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