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Nano-Lamination - A New Frontier in Manufacturing

Khan NT*

Department of Biotechnology, Faculty of Life Sciences & Informatics, Balochistan University of Information Technology, Engineering and Management Sciences, Pakistan

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***Corresponding author:** Nida tabassum khan, Department of Biotechnology, Faculty of Life Sciences & Informatics, Balochistan University of Information Technology, Engineering and Management Sciences, Takatu Campus, Airport Road, Quetta, Balochistan, Pakistan, Email: nidatabassumkhan@yahoo.com

Abstract

Nano-Lamination is a newly emerging technology of nanotechnology. With its vast applications in almost in every discipline of life, it is hoped that this may change the way we live our life. Though it is new introduced compared to other nanotechnologies, still scientists are focusing over it more than any other technology.

Keywords: Interface; stacking sequences; Electrolytic; Surface texture; Infrastructure

Introduction

Nano-lamination is a process through which we produce ultra-fine-grained solids that are fully dense and exhibits a high concentration of interface defects [1]. Nano-laminates properties depend upon their composition and thickness [2].

Fabrication of Nano-laminates

Nano-laminates are fabricated with atom-by-atom decomposition technology [3]. They are designed with variable stacking sequences and layer thicknesses [4]. There are mainly two ways of fabricating a Nano-laminate;

1. Atomic Layer decomposition
2. Electrolytic reduction [5,6]

Atomic Layer Decomposition

By atomic layer decomposition (ALD) technique such oxides can be produced that are thin in nature and are called hybrid thin film oxides [7]. ALD employs unique physical, chemical and electronic characteristics in fabrication process [8]. An example of one such nano-lamination is coating of rough oxide layer with smooth oxide layer to improve the surface texture according to the application [9].

Electrolytic Reduction

Electrolytic reduction process is used for the production of metals and metal alloys [10]. The thickness of these layers is in sub-μm and these methods can also be used to fabricate alloys with different properties like toughness, strength, corrosion and thermal properties that help interfaces to perform it functional role in nano-layers [11,12]. Nano-laminates can also be produced by using a bath technique, that bath contain numerous metal ions [13]. This method works by changing the current at a precise rate and selects different elements and, creates a layered structure [14]. With the help of this method, coating of up to a centimeter thickness can be performed [15]. One such example is nano-coated steel, which is 10 times stronger than ordinary steel [16]. It benefits in multiple ways like creating high-cost material at much lower price by coating lower-cost materials [17]. A company name Modumatel started the commercial production in 2010 [18].

Performance of Nano-lamination

The performance and efficacy of nano-laminations were tested in autoclave, where some Nano-laminated alloys displayed 8 times more resistance of carbon steel

to degradation, where as in some cases no measurable degradation was reported [19,20].

Applications of Nano-lamination

Nano-lamination applications include enhanced mechanical properties, energy storage and memory storage capacitors etc [21].

- **Building a better infrastructure for Oil and Gas industries**

A wide application of Nano-lamination is in Oil and Gas industry. As infrastructure of these industries needs corrosion-resistant, structure tubulars and high casing capacity [22,23]. Both tubulars and casings operate in extreme conditions like high pressure, temperature and in highly corrosive environments and also contain hydrogen sulfide (H_2S), carbon dioxide (CO_2) and chlorides [24]. Modumetal Company produces pumps, tubulars and valves that offer high corrosion-resistance and offer high-protection through a durable, high-strength Nano-laminated cladding of metal alloy [25]. Though, tubulars don't go-through the same reciprocating operations as pumps, still they frequently worn by placement and removal of downhole pumps, and monitoring tools, causing additional degradation resulting from both downhole corrosion and wear [26,27].

- **Electronic**

Another application of Nano-lamination is in the field of electronic. Through Nano-lamination technology, Nano-laminate dielectrics are fabricated with high efficiency of dielectric constant and high-insulation characteristics can achieve [28]. The generation of such dielectric material are under progress which possess giant dielectric constant characteristics like binary, modified single and perovskite oxides [29]. Electroplating is another application of Nano-Lamination [30].

- **Future Factory**

Nanotechnology has its applications almost in every discipline in different form like nano-cosmetics, nano-robotics, and nano-medicines but, the nano-lamination factory especially challenges the use of nanotechnology in food preservation and packaging industries [31]. Typically, the fruits and vegetable are coated with an artificial wax and then undergo plastic packaging for preservation and protection [32]. Currently this method is in developing face and, food scientist aims that in future synthetic edible nano-cellulose may be employed in coating [33].

- **Hair Treatment**

Nanotechnology has it application in our daily life in every regard, and it also change the way hair salon used to treat hair [34]. Future technology intends to provide one solution to all hair problems. It is progressing rapidly and proved to be a possible hair treatment, research says that it can provide a healthy treatment with shiny hair, and freeze free hair solution [35,36]. Nano-lamination technology strengthens hair by covering it with a specialized shiny foil-like lacquer and individual get benefit of thoroughly permeated [37]. Another technology is nano-mousse treatment which is a type of hair Botox treatment that give hair a smooth and silky texture, and restores damaged hair [38]. Many variations exist to this method, like bio-sleek Brazilian keratin is an advance process; it gives strength to hair and restore damage [39]. It provides strength to hair by infusing keratin into hair cuticles, and provides straightest, smoothest and softest hair [40]. Many other advantages are listed below:

- It prevents discoloration and protects damage against washout [41].
- Nano-lamination maintain hair moisture and control fizziness [42].
- It has been observed that, it adds volume and increase thickness of hair by 10% [43].
- It provides elasticity [44].
- It aligns the surface of hair by reducing hair roughness [45].
- It provides hair essential proteins like keratin, and help to protect it from damage and make them more flexible [46].

Conclusion

Nano-lamination is proved to be more sufficient in every possible way compared to other material and it is hope to be a new emerging technology.

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