Toward a sustainable interior design of health care facilities: "Applying green nano materials"

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Keywords الكلمات المفتاحية :

- Nano Cellulose Sheets
- Nano Clay
- Shellac
- Interior Design
- Sustainability
- Health Care Facilities

Abstract ملخص البحث :

The use of green nanotechnology in the field of interior design and furniture by using it in one of the health facilities, Healthcare facility design follows both form and quality. They serve a wide range of functions from medical applications (i.e. diagnostic, treatment, emergency rooms, clinics, etc.) to functional programs (i.e. waiting area, food services, patient rooms, office space, etc.). These facilities are spaces people live (temporally for treatment) and work in. For that, Designers of a healthcare facility are required to make healthcare interior design compatible with the principles of (green nano sustainable design) (GNSD). This will be achieved by applying green nano materials to give functional and aesthetic values for the interior space.

As interior designers, we thought of a mating business between green nano materials and interior design by experimentally test physical and mechanical properties of this materials and finding a way to apply in our interior space to achieve the requirements of interior design process and those people who inhabit this spaces.

The research manipulated three components (Nano cellulose fibers sheets, nano clays and shellac) together structural properties and studied The advantages of those green nano materials and future trends and applications in the field of interior design. Two properties were examined on the prepared samples on this paper Color measurements, UV ageing For the purpose of mating between green nano-materials and interior design for use in creating a comfortable environment for humans and environment friendly.

Introduction:

Nanotechnology uses are aiming to be diverse and multifaceted in that new materials are emerging with different property characteristics than we are used to working with, or better yet experiencing. As we delve deeper into the uses of nanotechnology, we should begin to ask ourselves what we can do with this technology, at this nano scale, that we could not do before to solve many of the critical problems that we as a people and interior designers face today.

As a result of any new trend have its advantages and disadvantages, so we must take the advantages of this technology and avoid its disadvantages, for that reason new concept was developed which is called GREEN NANO TECHNOLOGY. 1-

Green nano materials are environmentally friendly, nano cellulose fibers and nano clays Falls under this concept and called green nano materials, also shellac is considered …

As interior designers, we thought of a mating business between green nano materials and interior design by experimentally test physical and mechanical properties of this materials and in order to apply in healthcare interior space in order to make those spaces more effective for healing and Creating calming environments that promote health, safety, and well-being and promote an optimal healing environment for all involved.

The Research Problem:

1- Health risks which caused in healthcare facilities due to the use of non-green nano components in interior design finishing materials
2- The lack of knowledge of benefits of green nanotechnology and its useful effect in achieving functional and aesthetic values in healthcare facilities, and also help in making those spaces more effective for healing.

Research Objectives and Importance:

Upgrading functional and aesthetic values of interior design of healthcare facilities by using green nanotechnology through:

1- Using of Green nano Sustainable materials (GNSM) in healthcare facilities will help in making interior spaces of healthcare facilities more effective for healing.
2- Use of natural materials as shellac and green nano substances in healthcare facilities, helps to achieve the principle of sustainability and helps in maintaining the ecosystem
3- Using (GNSM) in interior design elements glass covers, reduce ultra violet ray emission in interior space and prevent its harmful effect.

Research Methodology:

- An experimental method:

All the testes were performed at the laboratories of national research center, Dokki, Giza, Egypt, According to test standards methods.

Descriptive analytical method: study and analysis of applying green nano sustainable tested materials in interior design of health care facilities.

Axis of Theoretical Study:

1- SHELLAC:

Shellac is the purified product of the natural material lac (tiny red insect no larger than an apple seed, which drinks the sap of trees, these tiny red insects contain within themselves the ability to make tree sap within their bodies and subject it to chemical changes that are still a mystery to science) which is secreted by the small parasitic insect Kerria Lacca on various host trees in India, Thailand and South- eastern Asia. Shellac is non-toxic, physiologically harmless and therefore listed as GRAS by the FDA.

Shellac is a natural resin that has been widely used as a protective material for wooden artifacts (e.g. furniture, musical instruments), due to its excellent properties.

It should be noted that the composition varies depending on the insects as well as the host tree from which the raw material is obtained

Fig. (1) Lac bags attached to the branch of a lac tree. Male, female and young lac insect greatly magnified

1-2 Uses of shellac:

1- Wooden furniture and musical instruments are usually coated with a protective layer that plays also an aesthetic role, because it so striklingly bringes out the beauty of the grains. Enhancement the appearance of grain where pure white shellac is used, also uses for hardwood floors.
2- Woodworks prefer shellac because it is easy working and remarkably quick drying, saving labor and expensive time. In addition it is tough, durable and very elastic, so that it provides a perfect undercoating for any other finishes[(1)]

[(1)] William Zinsser and co., inc 1927, "The story of shellac", www.donsbarn.com,(2018).

2- Nano cellulose fibers:

Natural fibers can be classified into different types depending upon their origin such as plant fibers and animal fibers. Natural fibers are of different types based on their source of origin from the plant such as leaf (PALF, sisal, banana etc.), bast (kenaf, jute, hemp etc.), fruit (OPEFB, coir) and seed (cotton, kapok). The mechanical properties of natural fibers (kenaf, jute) are found to be comparable with the commercial synthetic fibers, making the natural fibers highly preferable to synthetic fibers in automotive and other high end applications where weight and stiffness are of primary concerns.(1)

Natural fibers have many advantages such as renewability, abundance, low density, biodegradability, and last but not least, low cost. Despite this, the applications of these lignocellulosic fillers are still limited in industrial practice, in part due to their poor mechanical properties in general- although they have good specific mechanical properties given their low density.(2)

3- Nano Clays:

Nanoclays are easily available, environment friendly, low cost substances they are fine-grained crystalline materials.

Particle size, surface area, and aspect ratio are highly important characteristics desired in nanoclays. The length and breadth of the particles can range from 1.5µm. to a few tenths of a micron A small amount of nanoclay exhibits a high surface area; i.e., a nanoclay product is known with a surface area in excess of 750 m2 /g, which is an approximate equivalent to the area occupied by nine soccer fields. (3), (4)

4- Experimental:

Natural white shellac was purchased which is used in wood paints and used without any further purification.

Ethanol (100% EtOH) was used as a solvent for preparing shellac stock solutions.
-MONTMORILLONITE (MTM) Nano clay
-Bagasse Nano cellulose fiber sheets where used

Dissolve shellac in alcohol (ethanol) 100% with constant concentrations 18%, The nano-clay was divided on the shellac solution respectively with the following percentages: 0.6%, 1.2% and 2.2% for the formation of three different concentrations of shellac solution with nano-clay for use in covering the sheets of nano cellulose fiber, The envisaged clay NPs were dispersed in EtOH shellac solution (200 g/L Ultrasonic Homogenizer) The dispersion time was 5 min with power set at 50%.

All dispersions were used immediately after their preparation in order to avoid any possible NPs precipitation and to provide a good reproducibility for the further tests.

Nano cellulose fiber sheets (5 cm*5 cm*0.1 cm) was emerged in each solution with different concentration twice, also immerged twice in solution of 18% shellac only without clay, and a blank sheet was left as a control, between the two emergent a 24 hours was left.

The obtained samples was labeled as 18% zero clay (1), 18% 0.6(2), 18% 1.2(3), 18% 2.2(4) and blank sheet (5) respectively.

Note:

We observed from pre experimental tests that Addition of larger amounts of clay NPs to shellac solutions resulted in non-

(1) N. Saba, M. Jawaid and M. Asim, 2016" Recent Advances in Nanoclay/Natural Fibers Hybrid Composites", Springer Science+ Business Media Dordrecht, p.2

(2) Mohamed H. Gabr • Nguyen T. Phong • Mohammad Ali Abdelkareem • Kazuya Okubo • Kiyoshi Uzawa • Isao Kimpara • Toru Fujii, (15 February 2013)," Mechanical, thermal, and moisture absorption properties of nano-clay reinforced nano-cellulose biocomposites", Springer Science+Business Media Dordrecht 2013, p.819-820.

(3) Doaa Abelrahman Mohamed, Basma Mohamed Youssef, april, 2017, "Green nano materials to improve the quality of interior design and furniture environment", the 5th international conference of faculty of applied arts,.

(4) FAHEEM UDDIN, 2008," Clays, Nanoclays, and Montmorillonite Mineral", The Minerals, Metals & Materials Society and ASM International, DOI: 10.1007/s11661-008-9603-5

homogeneous dispersions, which were not investigated.

Table (1): name of the samples and percentage of clay and shellac in each sample.

Sample name	Nano Clay %	Shellac %
1	Zero nanoclay %	18% (constant)
2	0.6%	18% (constant)
3	1.2%	18% (constant)
4	2.2%	18% (constant)
5 Blank	Zero% nanoclay	Zero% shellac

A Varity of testing procedures and experimental technique were used in order to characterize all the materials and to evaluate the properties of the corresponding coating on nano cellulose fiber sheets. They include: Contact angle, the moisture adsorption (humidity), Water absorption, Tensile strength, Fire resistance, Color measurements, UV ageing.

4-1 Experimental steps:

1- Dissolve shellac in alcohol (ethanol) 100% with constant concentrations 18%.
2- Dived this solvent into 4 divisions in 4 different jars, the 1st jar add o.6% clay, in 2ndjar add 1.2% clay, in the 3rd jar add 2.2% clay, and leave the 4th jar 18% shellac without clay.
3- cut 5 samples of cellulose nano fiber sheets evenly 5cm*5cm with thickness 0.1 cm, emerge 4 samples in the 4 different concentrations of clay respectively 1st 0.6, 2nd 1.2, 3rd 2.2, 4th zero clay % respectively and leave the 5th blank .
4- Do measurement tests.

4-2 Testing methods:

All the testes were performed at the laboratories of national research center, Dokki, Giza, Egypt, According to test standards methods, All tests on treated nano cellulose fibers sheets were performed by examining the Combination of natural nano cellulose fibers with nano clay and shellac by immerging cellulose sheets in solution of shellac (constant concentration 18%) and nano clay with different concentrations of nano clays (0.6%- 1.2%- 2.2%) respectively, then do this measurement tests: (Color measurements, UV ageing) For each concentration.

4-2-1 Color measurements were taken by using **data color ultra scan PRO- Hunter lab**, determining the L*, a*, and b* coordinates of the CIELAB space, and the global chromatic variations ΔE.

4-2-2 Artificial ageing three major environmental influences, so called degradation factors are: temperature, UV radiation and humidity. One of these factors, the UV radiation, is of great impact on all organic macromolecules, like polymeric materials [(1)]

The tests were carried out on treated nano cellulose sheets (coating films) by UV 30 W/G30T8 UV lamp apparatus long life (made in Holland). Samples were situated at a distance of 15 cm from the lamps (T &RH = room temperature and room humidity) and irradiated for a total time of 520 h.

Color measurements (test and results):

1- L*a*b* refers to[(2)]: Regardless of formalized "color space name" you call it, it's important to know what L, A, and B stand for.

L*: Lightness
A*: Red/Green Value
B*: Blue/Yellow Value

$$\Delta E^*_{ab} = \sqrt{(L^*_2 - L^*_1)^2 + (a^*_2 - a^*_1)^2 + (b^*_2 - b^*_1)^2}$$

A- Color measurement Before UV:

Table (2): l, a, b &Δe values for Color measurement test Before UV for the 5samples

		L	a	b	Δe
1	**SH 18% + clay zero %**	48.63	-0.77	5.58	0.08
2	**SH 18% + clay 0.6%**	49.03	-0.54	5.57	3.53
3	**SH 18% + clay 1.2%**	48.32	-0.57	5.68	3.83
4	**SH 18% + clay 2.2%**	48.11	-0.44	5.44	3.68
5	**Zero shellac + zero clay (blank)**	49.54	-0.48	2.04	0.07

(lab/ RGB) Color picker, calculator and generator with high precision and contrast test for 5 samples before UV. [(3)]

[(1)] http://task39.iea-shc.org/
[(2)] https://www.xrite.com/blog/lab-color-space
[(3)] http://colorizer.org/

B- Color measurement After UV:

Table (3): l, a, b & Δe values for Color measurement test after UV for the 5 samples

		L	a	b	Δe
1	**SH 18% + clay zero %**	49.19	-1.07	8.98	0.03
2	**SH 18% + clay 0.6%**	47.35	-0.55	13.45	4.83
3	**SH 18% + clay 1.2%**	47.96	-0.78	11.70	2.96
4	**SH 18% + clay 2.2%**	47.23	-0.16	11.16	3.04
5	**Zero shellac + zero clay (blank)**	54.44	-1.14	7.58	5.45

(lab/ RGB) Color picker, calculator and generator with high precision and contrast test for sample 5 (Blank sheet) after UV. [1]

Percentage of difference in Lab, Δe values before and after UV:

Table (4): Percentage of difference in Lab, Δe values before and after UV.

Sample name	Percentage of diff. in L*value before and after UV	Percentage of diff. in a*value before and after UV	Percentage of diff. in b*value before and after UV	Percentage of diff. in Δe value before and after UV
SH 18% + clay zero %	1.15%	-107%	60%	-62.5%
SH 18% + clay 0.6%	-3.42%	-55%	141.47%	36.82%
SH 18% + clay 1.2%	-0.74%	-78%	105.98%	-22.71%
SH 18% + clay 2.2%	-1.82%	-16%	105.14%	-17.39%
Zero shellac + zero clay (blank)	9.8%	337.5%	271.5%	7685.71%

Best test result: sample (4), (SH 18% + clay 2.2) Percentage of diff. in Δe value before and after UV = -17.39%

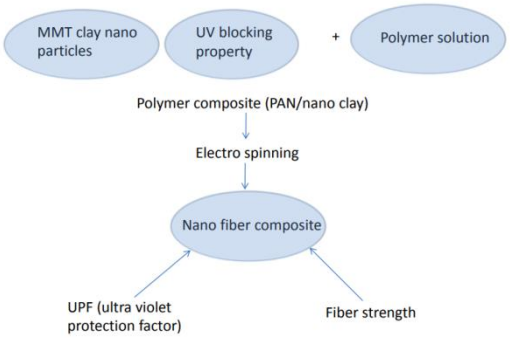


Fig (2) the nanoclays available and used as fillers in polymers produce nano fiber composite with UPF (ultra violet protection factor) and fiber strength. [2]

Table (5) final results for all tests for the 5 samples:

Sample No	Sample name	Color measure-ments Δe value	Color measure m-nts after UV ageing Δe value	Percentage of Color measurements difference in Δe value before and after UV
1	1- SH 18% + clay zero %	0.08	0.03	-62.5%
2	2- SH 18% + clay 0.6%	3.53	4.83	36.82%
3	3- SH 18% + clay 1.2%	3.83	2.96	-22.71%
4	SH 18% + clay 2.2%	3.68	3.04	-17.39%
5	Zero shellac + zero clay (blank)	0.07	5.45	7685.71%

3- The application of green nanotechnology in the field of interior design and furniture in order to achieve functional and aesthetic values

Interior surfaces, such as wall and ceiling finishes, glass coverings sticker, and furniture veneers, govern the quality of inside atmosphere to a great extent. The color, hue, and saturation that provide character to a health care center interior are essential for the quality of indoor atmosphere; thus, they have a significant impact on the mood and behavior of patients,

[1] Ibid

[2] Hassan Z. Harraz, April 2016," Nano clay and it's applications" , Tanta University,p.36

on the one hand, and on the psychological wellbeing of healthcare staff.(1)

Interior health care finishing materials should be selected based upon their appropriateness for the building type, and achieving functional and aesthetic values and achieving the principle of sustainability within the building during use.

1- GNSD (green nano sustainable design) principles when being used in health care center: suggested sample (sample no (3), (SH 18% + clay 1.2):

Aesthetics values:

Aesthetics is closely related to creating a therapeutic environment (homelike, attractive). Also, aesthetics is important to the health care center's public image, both for patients and staff, as well as the connection to healing and the patient experience.

Design of health care center must meet emotional needs of those who use such facilities at times of uncertainty, dependency, and stress.

Aesthetic considerations include:

1- Increased use of natural light, natural materials, and textures
2- Use of artwork, including nature scenes when views or access to nature are unavailable.
3- Attention to detail, proportions, color, and scale
4- Bright, open, generously scaled in public spaces
5- Homelike and intimate scale in patient rooms and offices
6- Signage that promotes optimal way-finding, satisfies the orientation needs of the first-time patient, allows easy navigation, and provides highly visible reference points immediately adjacent to each major entrance.(2)

There is some evidence that patients like to see a place that they consider “homely”. This seems to include having variety and texture in all matters. Variety is desirable in lighting, color and materials. Having materials that are tactile and with which you can interact seems desirable.(3)

Functional values:

A- UV protection:

UPF (ultra violet protection factor), is a vital for glass window sticker to reduce ultra violet ray emission in interior space and prevent its harmful effect.

B- sustainability:

Sustainability must be a consideration for the design of all health care facilities. Many sustainable design features can be incorporated into health care facility design, including day lighting, energy conservation, nontoxic materials and finishes, reduce maintenance requirements and toxic chemicals/ cleaners to maintain, and sustainable operations and maintenance.(4)

Sustainability Optimize interior Space and material Use:

While the world population continues to grow (to more than 9 billion by 2050), consumption of natural resources will continue to increase and the demand for additional goods and services will continue to stress available resources. It is critical to achieve an integrated and intelligent use of materials that maximizes their value, prevents 'upstream' pollution, and conserves resources. A sustainable building is designed and operated to use and reuse materials in the most productive and sustainable way across its entire life cycle, and is adaptable for reuse during its life cycle. The materials used in a sustainable building minimize life-cycle environmental impacts such as global warming, resource depletion, and toxicity. Environmentally preferable materials reduce impacts on human health and the environment, and contribute to improved

(1) Sarel Lavy, Manish Dixit, November 2012, "Wall Finish Selection in Hospital Design: A Survey of Facility Managers" ,p.15

(2) https://www.wbdg.org/space-types/clinic-health-unit

(3) Bryan R Lawson, Michael Phiri, 2003, "The Architectural Healthcare Environment and its Effects on Patient Health Outcomes", p. 18.

(4) https://www.wbdg.org/building-types/health-care-facilities

worker safety and health, reduced liabilities, and reduced disposal costs.(1)

Sustainable is one of LEED (Leadership in Energy and Environmental Design) principles.

LEED buildings save energy, water, resources, generate less waste and support human health.(2)

Sustainable considerations include:

1- Use healthy indoor materials that do not off-gas and that meet no- or Low-VOC requirements while also meeting hygienic and anti- microbial requirements.
2- Provide ample natural daylighting and views and access to nature wherever possible.
3- Consider the use of renewable energy sources to power the building or spaces and integrate energy efficient equipment into the facility.
4- Provide healthy indoor air quality.
5- Consider the use of modular construction when renovating or remodeling to reduce construction dust, debris, and waste.
6- Thoughtfully- designed and aesthetically- pleasing interiors are not only good for patients and their families; they improve the well-being of nursing staff as well.(3)

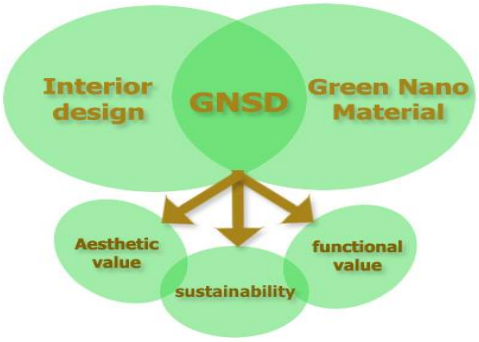


Fig. (3) Mating between interior design and green nano materials producing GNSD (Green nano Sustainable design) with aesthetic, functional and sustainable principles.

(1) https://www.wbdg.org/design-objectives/sustainable
(2) https://new.usgbc.org/leed
(3) https://www.wbdg.org/space-types/clinic-health-unit

c- Healthy building (HB):

"A healthy building is one that adversely affects neither the health of its occupants nor the larger environment." (4)

Green building is healthy for its occupants, more so than a conventional one. And this makes sense too: for example, a green building can use more natural materials, incorporate more day lighting, green buildings are often healthy buildings too.(5)

Why Green nano Sustainable materials (GSNM) considered as a Healthy building's interior materials (HBIM)?

Because of its Advantages:

1- Main advantage of designs use Green nano Sustainable materials; is that it lasts for a lifetime that it is strong, durable, Renewable and natural materials
2- It is inexhaustible, because its nano components are present in nature, easily available and durable.
3- Help in building modern day eco-friendly interior spaces, these techniques are important from the point of view of material and labor costs.
4- Reduce the damage caused by the waste as it create lesser amount of waste that reduces the landfills around the globe, it is environmentally friendly and can be recycled.
5- Green nano Sustainable materials include reclaimed products its main components. Thus, it reduces the need of manufacturing new materials and saves the precious resources.

(4) Levin, H., "Building ecology, September, 1995," an architect's perspective on healthy buildings" Proceedings of Healthy Buildings '95, Proceedings of the Fourth International Conference on Healthy Buildings, Milan, Italy.
(5) https://www.worldgbc.org/news-media/green-buildings- and-healthy-buildings\

6- Easy to maintain and are extremely long lasting.
7- Green nano Sustainable materials do not emit harmful emissions or toxic gases when a fire occurs because it's 100% natural component.
8- when the fire break out, Green nano Sustainable materials will be extinguished in a short time due to the presence of clay nano partials NPS, that is due to MMT nanoclay has been largely applied to enhance the barrier properties of polymeric materials towards gases(co2,o2).
9- Green nano Sustainable materials in interior spaces are good for human health; they are free from toxic materials, such as carcinogens, volatile organic compounds (VOC) and mold spores.
10- Green nano Sustainable materials are produced locally. This is greatly helpful as it lessens our expenses on shipping or transport and is a good way to help our local community.

Suggested design (Applying green nano materials):

Using Green nano Sustainable materials GNSM in heath care center to achieve Green nano Sustainable design GNSD:

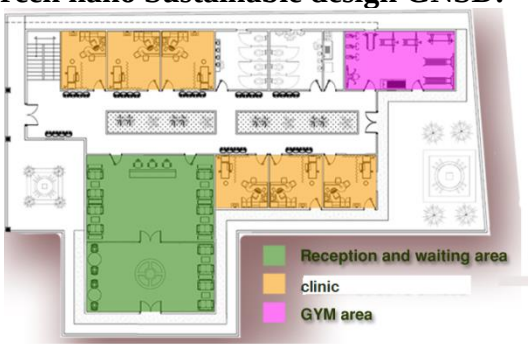


Fig. (4) First floor plan for suggested design for health care center

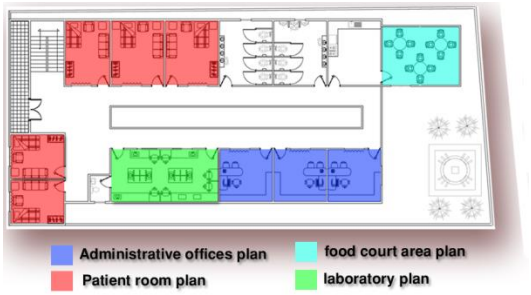


Fig. (5) Second floor plan for suggested design for health care center

1- Patient room:

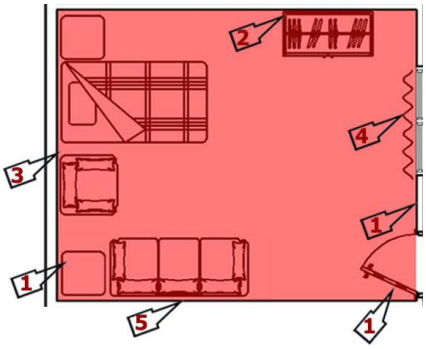


Fig. (6) Patient room plan

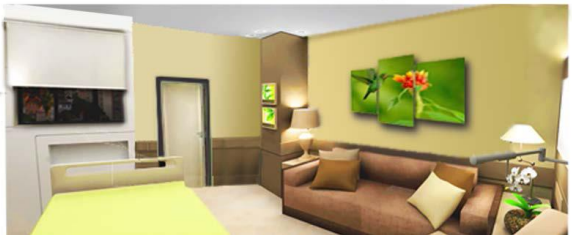


Fig. (7)

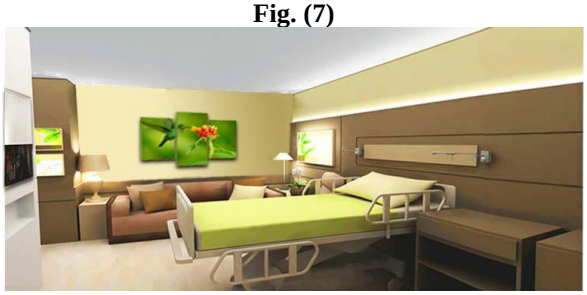


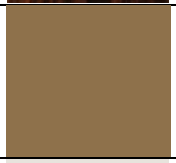
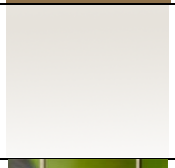
Fig. (8)

Fig. (9)

Fig. (10)

Fig (69),(70),(71) and (72) the interior design of Patient room for heath care center using green nano sustainable material (GNSM) as wallpaper, vertical blind, wood veeners and (tabloos) Artwork Paintings to give functional and aesthetic values.

Table (6): The functional and aesthetic value of the green nano sustainable material (GNSM) used in interior design space for Patient room in health care center

Code	Description	Texture	Functional value	Aesthetic value
1	Wood veneer		Used as a veneer for wood surfaces, color hue and saturation, ultra violet protection factor (UPF), fiber strength.	GNSM with wood effect gives warm nature to interior space, where it acts like wood veneer. Practical and fast solution to cover manufactured wood furniture to protect it and give natural effect of wood, with different colors.
2	Wood veneer			
3	Wallpaper		Used as a wall paper, color hue and saturation, ultra violet protection factor (UPF), fiber strength.	GNSM printed with flat color that agrees with the design of interior space, and the material used.
4	Vertical blind		Used as vertical blinds, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength.	GNSM can be used as vertical blinds with different colors and designs.
5	Decorative (tabloos) Artwork Paintings		Used as a decorative picture, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	GNSM Natural views can be printed on them as a framed picture, to give aesthetic value and a sense of comfort.

Clinic and administrative offices:

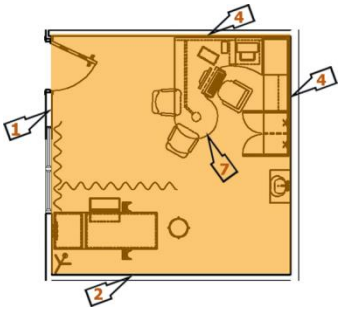


Fig. (11)

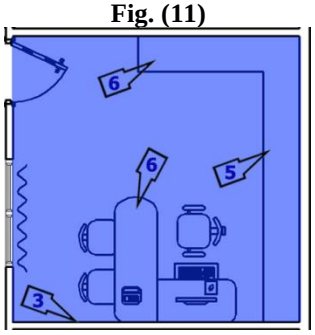


Fig. (12)

Fig. (11), (12) Clinic plan Administrative offices plan

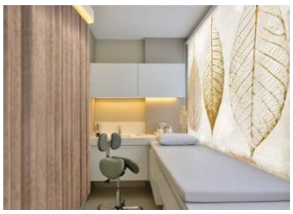


Fig. (13)

Fig. (14)

Fig. (15)

Fig. (13), (14) and (15) the interior design of clinic for health care center using green nano sustainable material (GNSM) as wallpaper and wood veeners to give functional and aesthetic values.

Fig. (16)

Fig. (17)

Fig. (16) and (17) the interior design of administrative office for health care center using green nano sustainable material (GNSM) as wallpaper, wood veeners and Colored Wood veneer to give functional and aesthetic values.

Table (7): The functional and aesthetic value of the green nano sustainable material (GNSM) used in interior design space for Clinics and administrative offices in health care center.

Code	Description	Texture	Functional value	Aesthetic value
1	wallpaper		Used as a wall paper, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	Green nano sustainable paper can be printed with nature- inspired designs from plant abstracted decoration with different patterns and golden color, it gives a feeling of luxury and relaxation.
2	wallpaper			
3	wallpaper		Used as a wall paper, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	Green nano sustainable paper can be printed with nature- inspired designs from flower, as the blue color gives a feeling of comfort and relaxation.
4	wallpaper		Used as a wall paper, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	GNSM printed with flat color that agrees with the design of interior space, and the material used.
5	Colored Wood veneer		Used as a veneer for wood surfaces, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	GNSM with flat color, where it acts like wood veneer. Practical and fast solution to cover manufactured wood furniture to protect it and give effect of painting, with different colors.
6	Wood veneer		Used as a veneer for wood surfaces, color hue and saturation, ultra violet protection factor (UPF) (color stability under UV effect.), fiber strength	GNSM with wood effect gives warm nature to interior space, where it acts like wood veneer. Practical and fast solution to cover manufactured wood furniture to protect it and give natural effect of wood, with different colors.
7	Wood veneer			

Conclusions:

1- Using green nano sustainable design in interior design, helps to achieve sustainable principle

2- Heath care center using green nano sustainable material (GNSM) as wallpaper, vertical blind, wood veeners

and (tabloos) Artwork Paintings to give functional and aesthetic values.

3- Green nano sustainable materials (GNSM) such as wallpaper, venners, etc…. It has color hue, and saturation feature and provide character to a health care center interior that is essential for the quality of indoor atmosphere.
4- Green nano sustainable materials (GNSM) have a significant impact on the mood and behavior of patients, on the one hand, and on the psychological wellbeing of healthcare staff.
5- When using GNSM in interior design functional values can be achieved such as:
   - Clean, water resistance: easily cleanable wall covering.
   - UV protection UPF (ultra violet protection factor), is a vital.
   - Easy when Installing Flexibility when installing, strength and durability is a must.
   - GNSM can be used in many ways in interior space as decorative wall paper, veneers for manufactured and semi manufactured woods, sticker for glass films (partitions & windows), decorative (tabloo) art work painting and vertical blinder to protect from uv.
   - Aesthetic value can be added to GNSM as it can be printed with various designs that serve the desired purpose from the interior space.

Recommendations:

It is recommended to:

1- Use GNSM in different interior design spaces as it helps to achieve the purpose of the interior space (official, residential…etc.) with th desired design (natural scene, wood texture, …etc.), so it can be used in interior space , as wall paper, veneer for wood, glass sticker), to give functional and aesthetic values.
2- Make GNSM as an Available technology in the market related to interior design materials.
3- Increase the awareness with GNSM and do more efforts to wide spread acceptance.
4- Correct the misconception toward green nanotechnology in general and especially GNSM that it is not expensive techniques but vice versa.
5- That government make national studied strategies toward encouraging the use of green nano technology especially GNSM in interior design field.
6- Those specialists in this field give training courses to learn consumers and also interior designers of the benefits of GNSM in the field, and its benefit toward human health and environment.

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