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Blending of Oil Painting Art and Packaging Design of Nano Cellulose Preparation

Yao Han*

China Foreign Affairs University, Beijing 100037, China

**corresponding author*

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Abstract: Packaging design in modern society has not only met people's needs for packaging, but also gradually integrated into the appreciation value of goods, becoming an integral part of goods. Polymer materials have become the mainstream materials in electronic packaging due to their light weight, good corrosion resistance and insulation properties. However, the thermal conductivity of polymer packaging materials is poor. A lot of attempts have been made to improve the thermal conductivity of packaging polymers. Nanofiber materials are added to polymers to improve their performance. In this paper, the combination of oil painting art and newly developed diamond nano cellulose is applied to packaging design, which can not only make the packaging flash the charm of color, but also increase the cultural atmosphere, so oil painting art has an important application in packaging design. In this paper, oxidized nano cellulose was prepared from bleached eucalyptus pulp and waste newspaper. The results showed that the effect of adding oxidized nano cellulose was better, and the addition of cationic starch could promote the strength of paper. Among them, oxidized nano cellulose can increase the tensile index, burst index and tear index of packaging paper by 4.8%, 9.25% and 2.29% respectively. In view of this, on the basis of expounding the characteristics of oil painting art, this paper deeply analyzed the integration concept of oil painting art and nano cellulose in oil painting art and souvenir packaging design. After that, it discussed the relevant strategies with examples, hoping to play a reference role for modern packaging design.

1. Introduction

With the increasing improvement of public living standards in recent years, the environmental pollution problem has become more and more serious, which has prompted the continuous

development and innovation of traditional packaging to adapt to and meet the changes in market demand, resulting in new packaging technologies such as reactive packaging and intelligent packaging. Diamond films have new characteristics of high thermal conductivity. At the same time, diamond materials are not conductive, which is very suitable for electronic packaging and other insulation occasions. Diamond films with good quality can be prepared by a variety of chemical vapor deposition (CVD) methods. In comparison, nano cellulose has certain advantages in environmental protection and flexibility at anytime and anywhere, meeting the basic requirements of social and environmental development for nano cellulose.

Now there are scholars' research on packaging design. Hu, Bin thought that oil painting, a painting method full of artistic sense, can create a clear and flexible picture shape by virtue of its unique painting techniques and bright and flexible color changes [1]. Togawa proposed that oil painting as a creative element in product packaging design can effectively break through the traditional packaging design methods, bringing more creative space and inspiration to designers. Through the deep integration of artistic aesthetics and marketing concepts, he promoted the continuous innovation and development of product packaging design and played a strong supporting role in strengthening the market competitiveness of enterprises [2]. Yang, Chao Ming found that no matter how the form of art design changes, cultural connotation was always the core factor and basic support for the long-term development of art design. Using oil painting art, designers should take the brand culture or product background as the starting point, take the enterprise management concept as the center, and deeply explore the artistic connotation and cultural connotation of different commodities. At the same time, they used specific painting techniques to integrate their interpretation and interpretation of commodity culture into packaging modeling design [3]. Al-Samarraie emphasized that color elements in oil painting should also be fully used in packaging design. With the help of a variety of painting technologies, the color of the picture should be changed and transformed. Through color contrast, the individual style of product packaging and the value attribute of product packaging should be displayed. In order to capture consumers' attention and stimulate their desire to buy, packaging needs to make full use of color elements and design exquisite packaging shapes with eye-catching visual effects, so that consumers can get material and spiritual satisfaction [4]. Barchiesi believed that oil painting, with its bright and bright color style, can effectively show the delicacy and sense of hierarchy of goods. It enhanced the added value and aesthetics of goods, gave people a good visual enjoyment, maintained artistry without losing texture, and opens up a new creative idea for packaging design [5]. The application of oil painting techniques to packaging can effectively improve the rigid veneer in traditional packaging design, and create novel and unique shapes through color pressing, scraping and other means, so as to effectively enhance the visual beauty and commercial value of packaging. At the same time, the skillful application of oil painting techniques makes the original typesetting design and color levels richer and richer through diversified means of expression, so as to achieve full expansion of packaging content.

At present, there are relevant researches on nano cellulose. Thomas found that cellulose based nanomaterials represented by nano cellulose not only retain the characteristics of natural cellulose, but also enable nanoparticles to have high strength, high crystallinity, high specific surface area and high tensile strength. It can significantly improve the photoelectric and electromagnetic properties of materials, so it has broad application prospects in many aspects [6]. According to Phanthong's research, nano cellulose was a pseudoplastic fluid with shear thinning, thixotropy, etc. NCC (Nanocrystalline cell) colloid can exist stably, which is due to the hydrogen bonding between NCC particles and the formation of three-dimensional network cross-linking structure [7]. Klemm proposed that compared with natural cellulose, nano cellulose has poor thermal stability. During the preparation of NCC, most cellulose chains were broken, resulting in a large number of cellulose

molecular chain breaking points and small molecular cellulose segments on the surface. Their phases can be arranged loosely and irregularly, forming many defect points [8]. Rajnipriya believed that the low-molecular-weight cellulose segments were affected by the strong adsorption force on the NCC surface, and were easy to absorb heat and decompose. The above factors make it less stable to heat than natural cellulose, but the acid hydrolysis process requires a higher acid concentration, which would bring some corrosion to the equipment, and it is difficult to conduct subsequent processing of the reaction [9]. Wang, Qianqian found that the surface hydroxyl group of nano cellulose can react with the polymer to form a graft polymer based on cellulose by introducing a polymer chain with special properties into nano cellulose, which can not only improve the dispersion stability of polar and non-polar media of nano cellulose, but also endow it with special functionality [10]. With the increasing consumption of oil, natural gas and other resources, environmental problems are becoming increasingly serious. Nanocellulose, a green renewable resource, would be widely used in many fields due to its unique nano size effect and special mechanical and optical properties.

Nanocellulose, derived from natural polymer compound cellulose, is one of the hot polymer nanomaterials in recent years. It is mainly extracted from renewable plant resources in nature, with strong biodegradability, high intensity and environmental safety. Nanocellulose can be widely used in the packaging industry. Nanocellulose has excellent performance and can improve part of the performance of packaging composites. In order to enhance the artistic charm of packaging, it is necessary and realistic to bring oil painting art into the nano cellulose packaging design.

2. Status of New Diamond Electronic Devices

With the continuous improvement of the integration of electronic components and the sharp increase of device heat, the applications of micro processing and power semiconductor devices often cannot operate normally due to high temperature. The heat dissipation of electronic components is a technical bottleneck restricting the development of electronic information industry. In the past, traditional materials have been unable to meet people's demand for their high performance, and the development and development of new electronic packaging materials have become the object that countries around the world are chasing [11].

(1) Common two-dimensional carbon film

Common two-dimensional carbon films include diamond-like carbon films, diamond films and nano diamond films. At present, diamond-like carbon (DLC) films and diamond films with micron grain size have been prepared in a large area using a variety of chemical vapor deposition technologies, as shown in Figure 1. Conventional polycrystalline diamond films are composed of micron sized diamond crystals. The surface of this diamond film is relatively rough, which restricts its application and development in many fields. The nano diamond film, with excellent tribological properties, provides a better polishing material for conventional CVD diamond film deposition, and the smooth nano diamond film also has important applications in chips, electrochemical electrodes, surface acoustic wave filters, micro electromechanical systems, and nano electromechanical systems. For self-use, C60 is used as carbon source and argon as carrier gas for different microwave equipment. It is believed that the nano diamond film prepared without hydrogen intervention has many potential applications in anti-friction coating, MEMS and electron field emission [12].

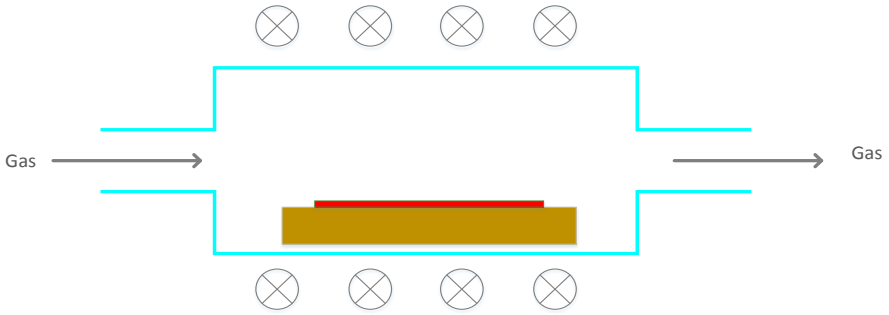

Figure 1. Chemical vapor deposition (CVD)

(2) Nano diamond film

At present, many researchers have synthesized nano diamond films through different ways, such as completely hydrogen free or little hydrogen phase systems. Since it was first reported in 1994 that nano diamond films were prepared by introducing a small amount of C60 into argon atmosphere using microwave plasma technology, nano diamond films have been a new hot spot in the field of diamond films. The research reports on nano diamond films in world academic journals are endless. It can be considered that diamond films with average grain size less than 200 nm can be called nano diamond films. Due to the variety of preparation methods and the complexity of structural characterization, nano diamond films are still controversial in many issues. Therefore, how to accurately characterize the nano diamond films has also attracted the attention of researchers. Because of the differences in their preparation methods, even the film growth mechanism has been fundamentally changed, so that the definition of nano diamond is controversial. The existence of atomic hydrogen is widely considered to be the key factor in the low pressure synthesis of micro diamond films. In terms of the growth of nano diamond films, people began to think that the biggest difference between hydrogen poor plasma and hydrogen rich plasma was that the hydrogen poor plasma produced nano diamond films, and the hydrogen rich plasma produced cylindrical micro diamond films, that is, nano diamond films can only be obtained in the hydrogen poor region. However, the mechanism of atomic hydrogen generation during the growth of nano diamond films is still unclear due to the nano diamond films prepared under hydrogen rich conditions. Therefore, how to correctly distinguish nano diamond films from micro diamond films in the current research of nano diamond films and the influence of hydrogen on nano diamond films need to be further improved.

3. Status of Preparation Methods of Nano Cellulose

(1) Nano cellulose

Nanocellulose refers to one-dimensional cellulose material with nanometer size separated from fiber raw materials through physical, chemical or biological treatment [13]. Nanocellulose can be divided into cellulose nanocrystals and cellulose nanofilaments according to cellulose. This paper focuses on the types, raw material sources and average diameter of nano cellulose prepared from wood or agricultural/forestry residues, as shown in Figure 2.

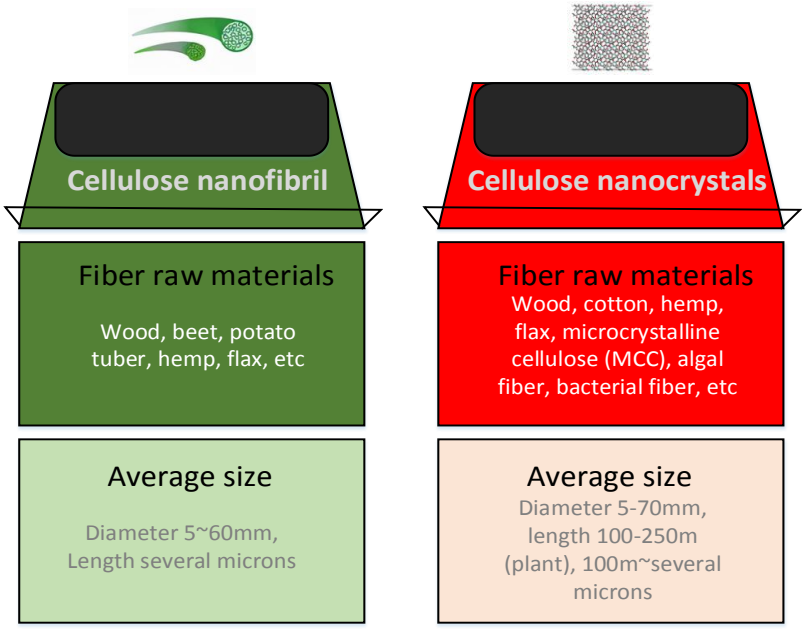

Figure 2. Classification of nano cellulose

(2) Diameter distribution of nano cellulose fibers

Figure 3 shows the diameter distribution of nano cellulose. It can be seen from the figure that the diameter of nano cellulose fibers is about several nanometers to 40 nm, and most of them are 10-20 nm. It can be seen from the diameter distribution map of nano cellulose fibers that nearly 66.32% of the nano cellulose fibers have diameters between 10-20 nm, only 2.27% of the nano cellulose fibers have diameters above 40 nm, and only 14.7% of the fibers have diameters below 10 nm.

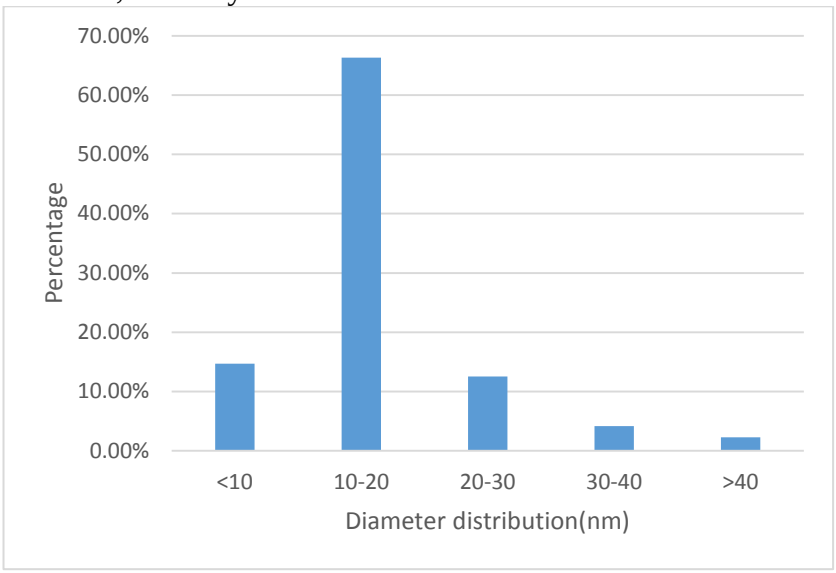

Figure 3. Diameter distribution diagram of nano cellulose fiber

(3) Preparation of cellulose nanofilaments

There are many methods to prepare cellulose nanofibers, among which mechanical treatment is the most commonly used. At present, the research mostly adopts the combination of pretreatment technology and mechanical treatment to prepare CNF. Pretreatment technology can not only significantly reduce energy consumption and chemical usage, but also can prepare nano cellulose

with different functional groups [14]. Common pretreatment methods mainly include oxidation pretreatment and enzyme pretreatment. In recent years, some green and effective pretreatment methods have been gradually developed, such as organic acid hydrolysis pretreatment, periodate oxidation pretreatment, eutectic solvent pretreatment, ionic liquid pretreatment and solvent assisted pretreatment [15]. The materials, methods and performance characteristics used to prepare CNF are shown in Table 1.

Table 1. Methods of preparing CNF from different raw materials

Raw material	Method
Prickly cactus peel	High-pressure homogenization
Bleached eucalyptus pulp	Grind
Microcrystalline cellulose	Micro fluidic treatment
Palm hollow fiber	Mechanical pretreatment+micro fluidic treatment
Soybean fibre	Freeze crushing+high-pressure homogenization
Rubber wood fiber	High intensity ultrasonic treatment
Bleached kraft pulp	TEMPO oxidation pretreatment+mechanical treatment
Bleached beech pulp	Carboxymethylation pretreatment+high-pressure homogenization
Bleached kraft bamboo pulp	TEMPO oxidation pretreatment+high-pressure homogenization
Bleached eucalyptus pulp	Mimic ionic liquid treatment+high-pressure homogenization

4. Oil Painting Art and Nano Cellulose Packaging Design

(1) Characteristics of oil painting art

Oil painting belongs to the category of western painting. The image created is exquisite and real, with a strong three-dimensional sense, and the subject matter is also very broad. Oil painting itself has a certain collection, artistic research characteristics, aesthetic value and so on, and can well show all aspects of a place. It is an important kind of painting in the historical development of western painting. The rich artistic characteristics of oil painting are very suitable for expressing the sense of texture and space, and have a high stability in painting. The expression techniques of oil painting mainly include rubbing, swinging, sweeping, dragging and pointing [16], as shown in Figure 4.

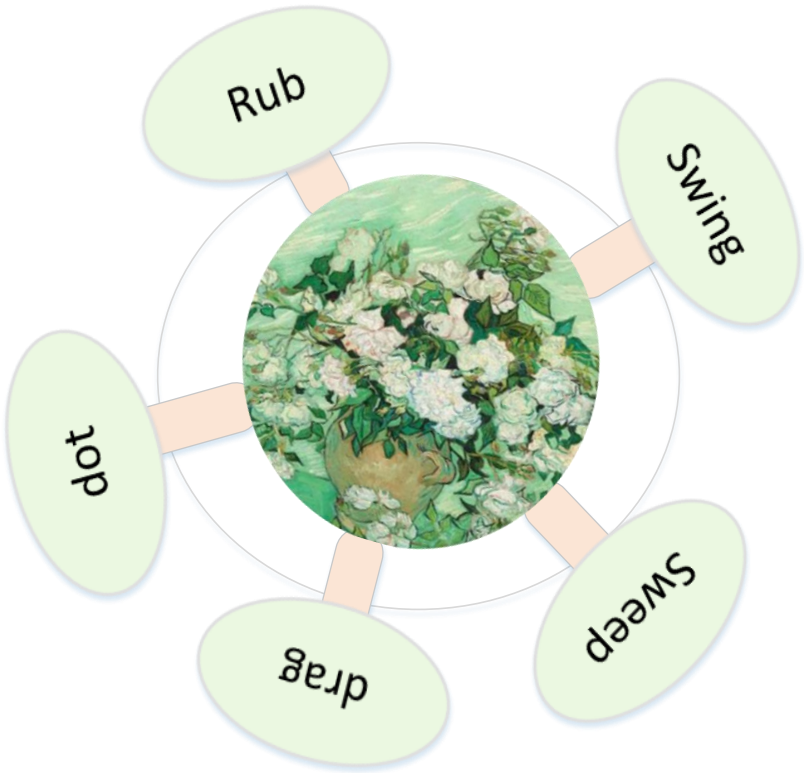

Figure 4. Expression techniques of oil painting

(2) Thoughts on the Integration of Oil Painting Art and Nanocellulose Packaging Design

Oil painting belongs to the category of western painting. It has the characteristics of bright and rich colors, exquisite realism, strong stereoscopic sense, and a wide range of themes. The unique expression techniques of oil painting can reflect the changes of color subtly, and at the same time, it can depict the details of the painting object very realistically. Of course, there are also some rough and abstract painting techniques, which can exquisitely express the level and texture of the object, highlight its artistry, and then constitute the appreciation value. As far as the significance and characteristics of oil painting are concerned, it is very rich in color and very expressive. These elements are very important in nanofiber packaging design, so it is natural to integrate oil painting art into nanofiber packaging design [17]. When facing oil painting, the first information that the viewer can get is the color of the photo. For oil painting creators, when language and words cannot accurately express their rich and unique feelings, they resort to the art of painting, using rich colors and special techniques of expression to make their feelings concrete and presented to the audience, so as to resonate and achieve emotional exchanges. Nanofiber packaging design is no exception, and designers also want to use artistic design to arouse consumers' emotional resonance. For packaging designers, they cannot communicate with consumers in terms of language and words. Packaging is the only channel for communication. At this time, designers can make unique choices and designs of colors to attract consumers' attention, so that they can be attracted by colors and accept souvenirs. This color centered design idea just fits in with the color display of oil painting art, so nanofiber packaging designers can get inspiration from it [18].

(3) Problems in the blend of oil painting art and nano cellulose packaging design

Today, with the increasing development of art design, people also pay attention to the application of oil painting art in nano fiber packaging design, but the problems that appear in it are

ignored to varying degrees, specifically:

1) Lack of market positioning and packaging design concept of nano cellulose.

The product market positioning is coordinated by product design, market pricing, advertising strategy and marketing, which is the key to market development. At present, oil painting art is integrated into the design of nano cellulose packaging to ensure its commercial value while enhancing its artistic and cultural value and promoting product appreciation [19]. However, in the process of research, development and operation of nano cellulose, some businesses blindly follow the trend in view of the age, gender, cultural background and other factors of target consumers, resulting in serious homogenization of nano cellulose varieties and uniform packaging. It cannot form distinctive artistic symbols, and cannot attract consumers' attention and purchase. It does not design various specifications and grades of packaging according to the consumer level, but carries out unified design, which is limited to the practical effect of nano cellulose packaging. It is difficult to promote products at the cultural and artistic level, and it is difficult to stimulate consumers to buy.

2) The effect of exploration and application of oil painting art is not very good.

The brand image is presented to the public in the form of nano cellulose packaging design. Designers should give consideration to regional characteristics and enhance the sense of belonging to the origin when designing and creating. In the environment of the prosperity and development of modern art, the achievements of oil painting art in various places are also very rich. Some optimized writers took regional culture as nourishment and created excellent oil paintings to reflect the overall development and change of society, as well as the people's living environment and aesthetic needs. These oil paintings have brought a lot of resources to the local nano cellulose packaging design. However, through research, it is found that although some regions have rich regional culture and rich oil painting achievements, the application of nano cellulose packaging design to oil painting related elements is less. Some products only directly apply local scenic spots or buildings to packaging design in the form of pictures, which makes nano cellulose packaging design without due beauty and cannot well show the uniqueness of local regional culture. It is not satisfactory in both appearance and connotation [20].

3) The application of nano cellulose in packaging design to the elements of oil painting art is unreasonable.

The integration of oil painting art into the nano cellulose packaging design is not a simple reproduction of oil painting works on the packaging cover, but requires designers to comprehensively consider various factors and give play to unique creativity, so as to form packaging design works with aesthetic harmony characteristics. However, at present, when oil painting art is applied to the design of nano cellulose packaging, there are unreasonable visual elements and graphic elements on the packaging. Color elements and font elements are not harmonious enough. The packaging materials and forms are simple, which cannot well show the artistic effect of oil painting elements. The functional classification of nano cellulose packaging is simple. The application of oil painting elements in packaging design is relatively rigid, which cannot produce emotional interaction with consumers, thus affecting the overall design effect of nano cellulose packaging.

(4) The integration of oil painting art and nano cellulose packaging design

The most prominent feature of oil painting is its color, texture and texture. Therefore, the choice of color has an important impact on the design results of nano cellulose packaging.

1) Incorporate oil painting color into nano cellulose packaging design

The art of oil painting has the characteristics of colorful, exquisite and real pictures, and strong three-dimensional sense. Different colors are integrated into the nano cellulose packaging, which can give people a different feeling. Different colors can often make people have different feelings,

and even affect the sales of goods.

2) Integration of oil painting texture and texture with nano cellulose packaging design

The texture and texture of the oil painting itself are also very important, for example, the smooth performance of metal in the painting can bring a sense of cool. The picture shows the fluctuation of wood, which can give people a sense of peace and freedom. The picture shows the content of ceramics, which can give people an elegant feeling. The softness of leather screen can bring a warm feeling to people naturally. For another example, there are pictures reflecting the wood texture. The texture itself would make the dazzling light more soft, which would better meet the physiological comfort of people's eyes when reflecting the light. If the product itself is mostly made of some wood, its nano cellulose packaging design products can also be used to design oil paintings based on trees. In a word, oil painting can show different materials and often bring different psychological feelings to people. In order to improve the aesthetic value and connotation of packaging of nano cellulose products, the integration of oil painting art into packaging design has a deep exploration significance.

3) A case study on the integration of oil painting art and nano cellulose packaging design

An excellent oil painting can well show the author's intentions and thoughts, communicate with the audience, show the impact between inspiration and culture, or give inspiration to the audience on the heart. If they want to firmly grasp the psychological, physiological and visual needs of buyers under the same nano cellulose packaging, it should not just focus on the product itself. Its nano cellulose packaging design cannot be ignored. As the external skin of the commodity, packaging design has not been clearly explained by many designers from the commodity itself. Designers need to find more tips from their nano cellulose packaging design to further explore the value and significance of the commodity. Nanocellulose packaging is one of the most important manifestations of product differentiation. By combining the pictures and words of the nano cellulose packaging design, customers can obtain a variety of information about the product in a very short time. It has met the requirements of touching people's minds on the outer packaging, so that buyers can get visual and psychological satisfaction, and have a new understanding of the goods.

5. Nano Cellulose Based on Density Functional Theory

The basic idea of density functional theory is that the ground state physical properties of atoms, molecules and solids can be characterized by the density function of particles. It is assumed that the many body effects related to the exchange of nano cellulose are included in the energy term $E_{xc}[n]$ related to the exchange. After comparison, it can be found that $E_{xc}[n]$ can be expressed as follows:

$$E_{\mathrm{xc}}[n]=\langle T\rangle-T_S[n]+\langle V\rangle-E_{Hartree}[n] \tag{1}$$

Here, the charge density n of nano cellulose is a function of both the spatial position r and the electron spin σ. The energy functional E_{KS} of nano cellulose is used to variational the orbit, and the corresponding formula can be obtained:

$$\left(-\frac{1}{2}\nabla^2+V_{\mathrm{ext}}(r)+V_H(r)+V_{xc}(r)\right)=\varepsilon_i \tag{2}$$

Among them, $V_{\mathrm{ext}}(r), V_H(r), V_{xc}(r)$ are the external potential, Hartree potential and exchange correlation potential of nano cellulose respectively.

The effective potential $V_{eff} = V_{\text{ext}}(r) + V_H(r) + V_{xc}(r)$ in the formula is determined by the electron density.

The total energy of nano cellulose is obtained by introducing the formula:

$$E_0 = \sum_i^N \varepsilon_i - \frac{q^2}{2}\int d^3r \int d^3r \frac{n_0(r) n_0(r')}{|r - r'|} - \int d^3r V_{xc}(r) n_0(r) + E_{xc}[n_0] \tag{3}$$

In the formula, ε_i is the eigenvalue of KS formula. The electron exchange of nano cellulose was treated by linear combination method to obtain accurate exchange energy:

$$E_{XC} = c_1 E_X^{HF} + c_2 E_{XC}^{DFT} \tag{4}$$

Among them, E_X^{HF} is Hartree fock (HF) exchange energy, and E_{XC}^{DFT} is energy related to LDA or GGA exchange. After the dispersion force is locally modified to the total energy formula, the dispersion corrected DFT is the most widely used and widely confirmed calculation method. The basic idea is to modify the dispersion force calculation results through a simple and easy calculation approach under the framework of conventional nano cellulose density functional theory, which is more efficient in energy gradient calculation and structure optimization. The dispersion force in the formula for calculating the total energy of nano cellulose is modified, and the following expression can be written:

$$E_{DFT-D} = E_{KS-DFT} + E_{\text{disp}} \tag{5}$$

E_{KS-DFT} is the total energy obtained by density functional theory self-consistent calculation of nano cellulose; E_{disp} is the empirical dispersion correction term:

$$E_{\text{disp}} = -S_6 \sum_{i=1}^{N_{at}-1} \sum_{j=i+1}^{N_{at}} f_{dmp}(R_{ij}) \tag{6}$$

In the formula, N_{at} is the number of atoms in the system, and R_{ij} is the distance between atomic pairs ij.

S_6 is a global variable, which is determined by the functional type selected in DFT calculation. Meanwhile, the expression of suppression function f_{dmp} is:

$$f_{dmp}(R_{ij}) = \frac{1}{1 + e^{-d(R_{IJ}/(R_r - 1))}} \tag{7}$$

In the formula, R_r is the sum of the van der Waals radii of atoms, and this geometric equilibrium expression can give good results:

$$C_6^{ij} = \sqrt{C_6^i} C_6^j \tag{8}$$

From the electric potential I_{p} and polarizability α between atoms, the value of C_6 coefficient can be obtained from London formula:

$$C_6^{as} = 0.05NI_p^a a^a \tag{9}$$

When calculating the total energy of the relative system, the modified formula can be described as follows:

$$E_{xc} = E_x^{LDA/GGA} + E_C^{LDA/GGA} + E_C^{NL} \tag{10}$$

E_C^{NL} can be expressed as a double integral:

$$E_C^{NL} = \frac{1}{2}\iint \rho(r)\phi(r,r')\rho(r')drdr' \tag{11}$$

ρ is the electronic density of nano cellulose, r, r' represent the atomic coordinates respectively. The physical principle of its modification is that the average even polarizability is based on the local approximation of its frequency ω, and the total polarizability α is generated when integrating it.

$$\alpha(\omega) = \int a(r,\omega)dr \tag{12}$$

Use dielectric constant:

$$\varepsilon(\omega) = 1 - \frac{\omega_p}{\omega} \tag{13}$$

Approximately, electron exchange and related effects of nano cellulose are not considered. Based on this model, Dirac increases the local approximation of electron exchange interaction and gives the functional expression of electron energy under the external potential $V_{ext}(r)$:

$$E_{TF}(n) = C_1\int d^3 r n(r)^{5/3} + \int d^3 r V_{ext}(r)n(r) \tag{14}$$

The Hamiltonian energy of a multi particle system in the external potential $V_{ext}(r)$ can be written

$$H = -\frac{h}{2m}\sum_i \nabla_i^2 + \sum_i V_{ext}(r_i) + \frac{1}{2}\sum_{i\neq j}\frac{e^2}{|r_i - r_j|} \tag{15}$$

The corresponding energy functional of nano cellulose is

$$E_{HK}[n] = T[n] + E_{\text{int}}[n] + \int d^3 r V_{\text{ext}}(r)n(r) + E_{\text{X}} \tag{16}$$

Among them, $T[n]$ and $E_{\text{int}}[n]$ contain all the kinetic energy and potential energy of the interaction system, E_{X} is the interaction energy between nuclei, and $V_{ext}(r)$ contains the nuclear interaction and the potential of the external field.

The electron density of this hypothetical system nano cellulose is defined as the sum of squares of orbits with different spin σ:

$$n(r) = \sum n(r,\sigma) = \sum_\sigma \sum_{i=1}^{N^\sigma} \left|\Psi_i^\sigma\right|^2 \tag{17}$$

The kinetic energy T_S of the non-interacting system is:

$$T_S = -\frac{1}{2}\sum_{\sigma}\sum_{i=1}^{N^{\sigma}}\left\langle \Psi_i^{\sigma}\left|\nabla^2\right|\Psi_i^{\sigma}\right\rangle = \frac{1}{2}\sum_{\sigma}\sum_{i=1}^{N^{\sigma}}\left|\nabla\psi_i^{\sigma}\right|^2 \tag{18}$$

Its classical Coulomb interaction is defined here as the interaction between the electronic density $n(r)$ of nano cellulose and itself, namely:

$$E_{Hartree}[n] = \frac{1}{2}\int d^3r d^3r' \frac{n(r)n(r')}{|r-r'|} \tag{19}$$

In this way, the energy functional of the system nano cellulose under the approximate multi-body interaction can be expressed as:

$$E_{KS} = T_S[n] + \int dr V_{ext} n(r) + E_{Hartree}[n] + E_X + E_{xc}[n] \tag{20}$$

6. Discussion on Application of Nano Cellulose in Packaging

In this study, eucalyptus pulp oxidized nano cellulose was prepared from bleached eucalyptus pulp and waste newspaper, and two kinds of oxidized nano cellulose were used as paper additives in eucalyptus pulp paper package to study the effect of oxidized nano cellulose on packaging paper.

(1) FT-IR analysis

Figure 5 shows the infrared spectra of bleached eucalyptus pulp and waste newspaper deinked pulp before and after oxidation. It can be seen from the spectrogram that the absorption peaks of oxidized eucalyptus wood nano cellulose and waste newspaper nano cellulose are strengthened at 1418~1611 cm. These two absorption peaks are attributed to the symmetric stretching vibration and asymmetric stretching vibration of the carboxyl group, indicating that the carboxyl group is successfully introduced into the nano cellulose through the system oxidation, and the oxidized nano cellulose is successfully prepared. If the oxidized nano cellulose is added to the pulp as an auxiliary, it can be closely combined with the pulp fiber, which may improve the strength of the paper.

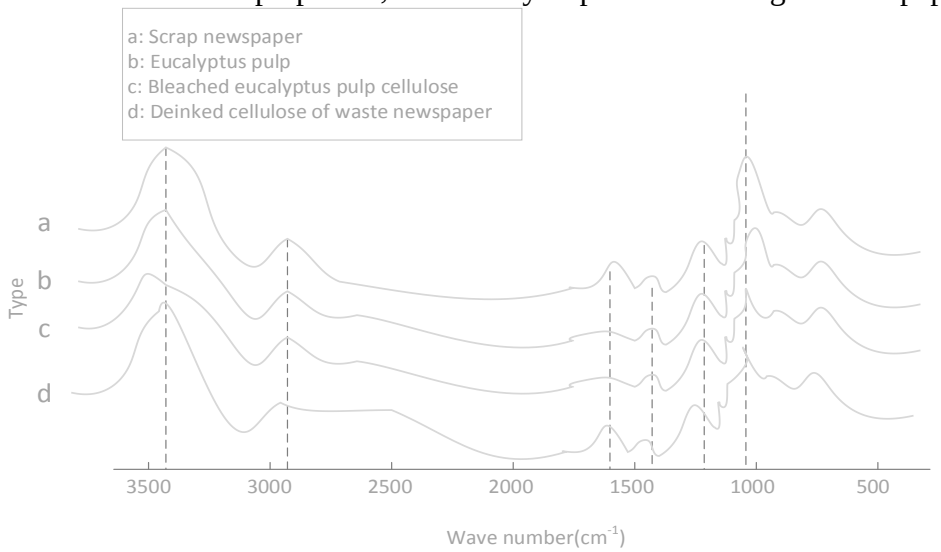

Figure 5. Infrared spectrogram of two raw materials before and after oxidation

(2) Effect of oxidized nano cellulose on properties of packaging paper

1) Tensile index

Figure 6 shows the tensile index of two kinds of oxidized nano cellulose and cationic starch on packaging paper. It can be seen from the figure that when the amount of oxidized nano cellulose in the pulp is 0~6%, the paper tensile index increases with the amount of oxidized nano cellulose.

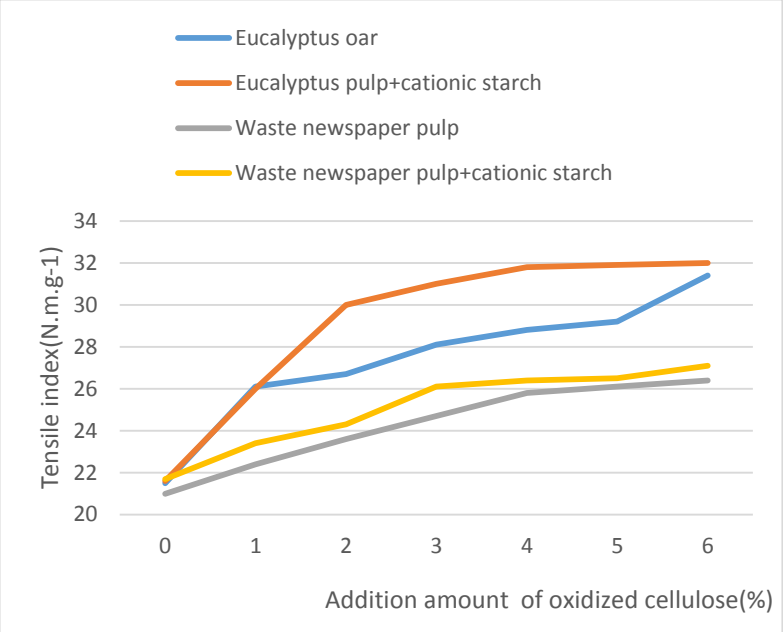

Figure 6. Effect of two kinds of oxidized nano cellulose and cationic starch on paper tensile index

2) Burst index

Figure 7 shows the bursting index of two kinds of oxidized nano cellulose and cationic starch on packaging paper. It can be seen from the figure that when the amount of oxidized nano cellulose is 0~6%, the bursting index of paper increases first and then tends to be flat with the addition of oxidized nano cellulose.

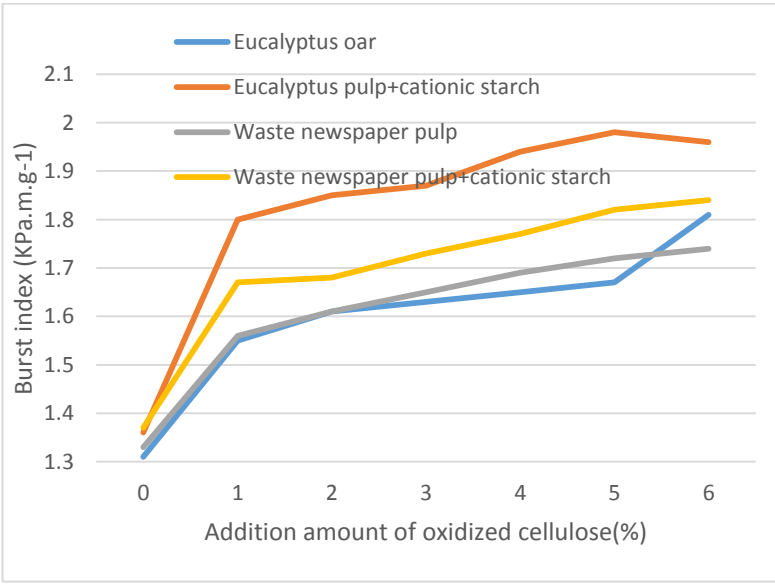

Figure 7. Effects of two kinds of oxidized nano cellulose and cationic starch on bursting index of paper

3) Tear index

Figure 8 shows the change of tear index of packaging paper caused by two kinds of oxidized nano cellulose and cationic starch. It can be seen from the figure that when the amount of oxidized nano cellulose is 0~6%, the change trend of the overall tear index of the paper is first increased, then gradually decreased, and finally stabilized.

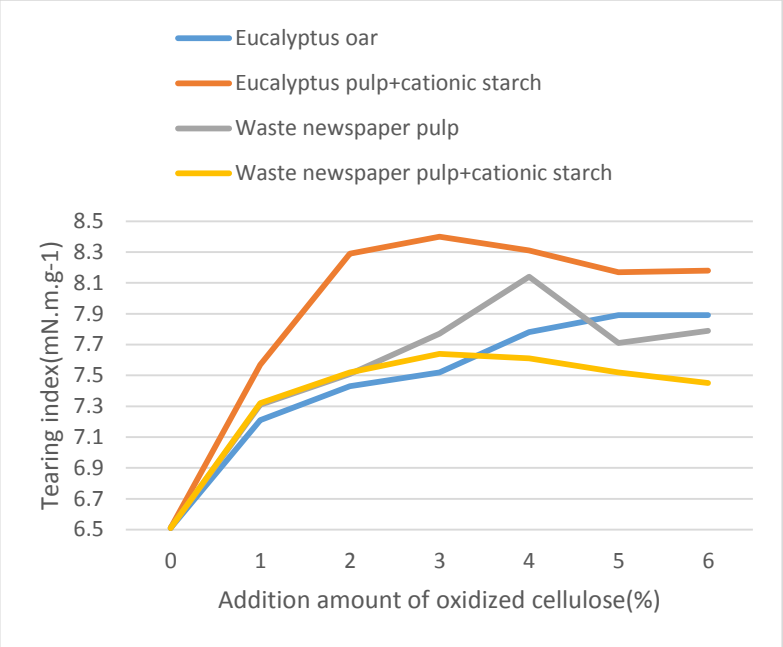

Figure 8. Effect of two kinds of oxidized nano cellulose and cationic starch on paper tear index

To sum up, it can be seen that the addition of 1% cationic starch helps to improve the strength of the two kinds of oxidized nano cellulose on the paper. Among them, oxidized nano cellulose can increase the tensile index of packaging paper by 4.8%, the burst index by 9.25%, and the tear index by 2.29%. It can be concluded that oxidized nano cellulose can significantly improve the bursting index of paper when it is used as a packaging paper additive, and the addition of cationic starch can improve the tensile index, bursting index and tear index of packaging paper.

7. Conclusion

As described in this article, the application of nano cellulose in the packaging field has developed rapidly, but it is still in the initial stage. Nano cellulose has shown many potential development strategies or is being implemented. It would take some time to release the application potential of nano cellulose, but there is no doubt that nano cellulose is a new environment-friendly material with unlimited development prospects. At the same time, the integration of oil painting art into nanofiber packaging design not only conforms to the development trend and application value of packaging design, but also can effectively meet the cultural pursuit of modern people for art. This requires designers to keep up with the forefront of the times, grasp the cultural psychology of consumers, and constantly hone design skills and artistic culture, so as to design packaging works that can not only meet the market aesthetic, but also have better artistic value.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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