

Application of Poly (vinylbutyral) Nanocomposites in Environment Design

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Abstract: This text passed an adoption to totally mix a method to lead to make even PVB/SiO₂ compound material into the nano SiO₂ grain son in gather the PVB material.. With the UV-VIS, FT-IR, XRD, SEM etc. modern tested means token tiny view facial look, structure and optics function of material. Result enunciation:because the lead of the nano SiO₂ grain son go into and make the compound material of the PVB/SiO₂ have good ultraviolet rays to shield function; Meanwhile, the tenacity of material gets an obvious exaltation, it splits an elongation rate is 8 times than the for pure PVB material.

Key words: nanocomposite; mixing process; nanometer silica; environment design

1. FORWARD

In the past 10 years, synthetic nano-composite has developed very fast and received general concern in material science and industry, raising an upsurge of studies on nanometer materials. Polymer / lamellose metasilicate nano-composite combines perfectly both the rigidity, dimensional stability, heat stability of inorganic materials and the toughness, machinability, dielectric property of macromolecule materials. It will have extensive applications in the future. With the deepening of studies on nanoparticle properties, people have found that a lot of inorganic nanometer oxides, such as SiO₂, TiO₂ and ZnO, etc., demonstrate the optical properties completely different from those of bulk phase materials [1-3]. Therefore, by introducing some inorganic nanoparticle into PVB materials with good transparency in the visible light region, it may bring a significant change to the properties of PVB in the ultraviolet region, which is of great importance to expand the application of this material. Especially when applied to materials of environmental design, it can solve effectively the problem of light pollution caused by ultraviolet ray.

Nanometer materials mean in the materials, the microstructure size including microgranule size, grain size, distribution of phase 2 enzyme, should be less than 100nm. Meanwhile, the materials prepared

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should have characteristics different from those in regular materials. None of the two can be dispensed with. Because of the small particle size, unsaturated bonds and hydroxy groups of different link states on the surface, the surface of nanometer SiO₂ is of high energy and high polarity. As a result, nanometer SiO₂ is very apt to demonstrate the coalescent property, which makes it difficult to disperse in macromolecule materials with the surface of low energy and low polarity.

In order to overcome this problem, we can make use of momentary and partial high temperature and high pressure produced by supersonic cavitation, KH-570 added as dispersing agent, to disperse SiO₂ coacervate. Put several ml. of pure KH-570 into a beaker, mix with nanometer SiO₂ and ethanol (the amount of coupling agent accounts 1% of nanometer SiO₂), stir for 2 hours at a high speed, and keep the rotational speed at 2000 r/min. After the soliquid is formed, put it into a 50-ml beaker and use a supersonic shaker to oscillate the beaker 5 hours without stop. Then modified SiO₂ ethanol soliquid is formed. Finally, increase the temperature to 80 °C to volatilize the solvent and the remainder are modified nanoparticles[4-7]. This study focuses on the preparation of poly-vinyl-butylal nano-composite and its application in environment design.

2. EXPERIMENT PART

2.1 Preparation of PVB resin

Put 10g PVA into a flask of 250ml and with a blender, reflux condensing tube and a thermostat. Then add water in it(with 10% solution), and the amount of water needed should be calculated in advance. Heat the flask as long as the PVA in it starts to melt, and keep the temperature not exceed 80°C in the whole process.

After PVA melts thoroughly, add hydrogen peroxide in the flask to make the degradation of PVA , to ensure that the weight ratio between PVA and the latter is roughly 10 : 200. Several minutes later lower the system temperature to 39°C, then add hydrochloric acid and butyl baldheaded in and keep the thermostat at 3h. Leave the precipitation separated out from the process for some minutes, and then blend with sodium hydroxide solution to counteract.

Filter the mixed solution and then wash the leached residue with water. Dehydrate the leached residue and put it in an oven to dry it, and make sure the temperature below 57°C. The white and flowing powder is PVB powder.

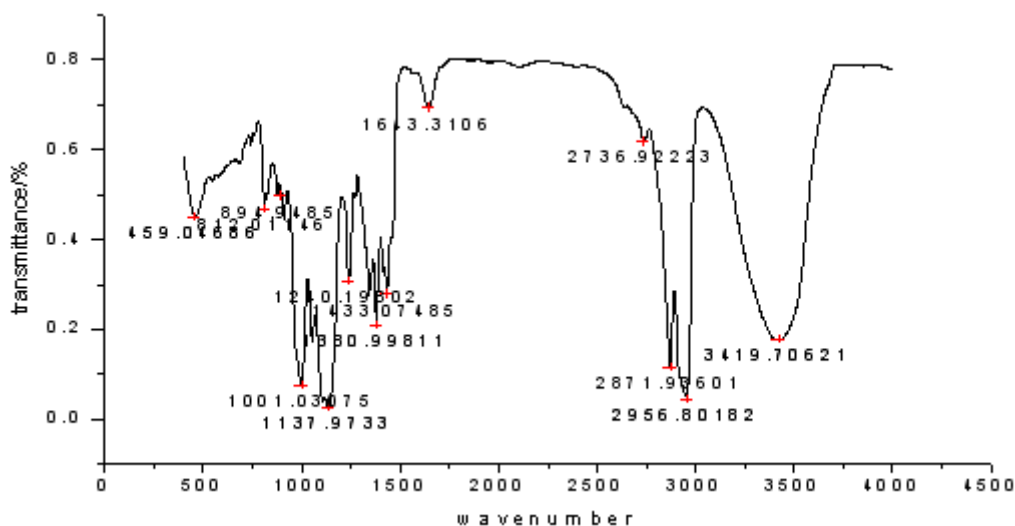
2.2 Modification of PVB resin and applied in laminated glass

Put dried PVB powder in absolute ethyl alcohol, and turn it into slimy and transparent solution. Measure modified SiO₂ at different amount from absolute PVB, and blend it under the influence of ultrasonic. The SiO₂ got from the mixture of two solutions compare with absolute PVB is 0·2·4·6·8·10 PVB/SiO₂ weight percentage blender. Pour the solution with SiO₂ into single glass, which is sealed with latex. Use a glass rod to scrape the liquid surface. Take some of the mixed solution, and pour it in a clean mould, and keep it under indoor temperature for a while, and take it out when it is dry enough. This way, a transparent coating of 0.2 mm~0.3 mm thick is ready for use.

3. ANALYSIS AND DISCUSSION OF THE RESULTS

3.1 spectrogram analysis of compound material infrared assimilating

Picture one is infrared assimilating spectrogram of PVB/SiO₂ compound material

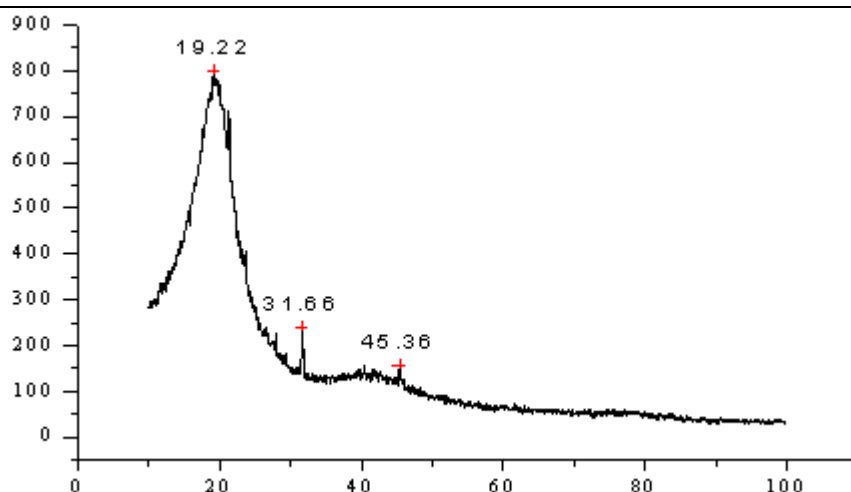


Picture 1 is infrared assimilating spectrogram of PVB/SiO₂ compound material

Comparing 3435.136cm⁻¹ ($\Delta \gamma \approx 40\text{cm}^{-1}$) Hydroxyl absorption peak in pure SiO₂ infrared assimilating(picture c) with 3468cm⁻¹ Hydroxyl absorption peak in pure PVB infrared assimilating(picture b), it is still maintained after forming PVB/SiO₂ compound material. But the peak position moves to the Low wave number 3319cm⁻¹, maybe because of the Hydrogen bond effect between the hydroxide radical which is forming compound material SiO₂ and the hydroxide radical of PVB. The hydroxide radical of the compound material Absorption peak becomes wider and infrared shift. What's more, in compound material(picture c) 1643cm⁻¹ absorption peak which is belong to C=O expansion and contraction vibration absorption of PVB, high and wide

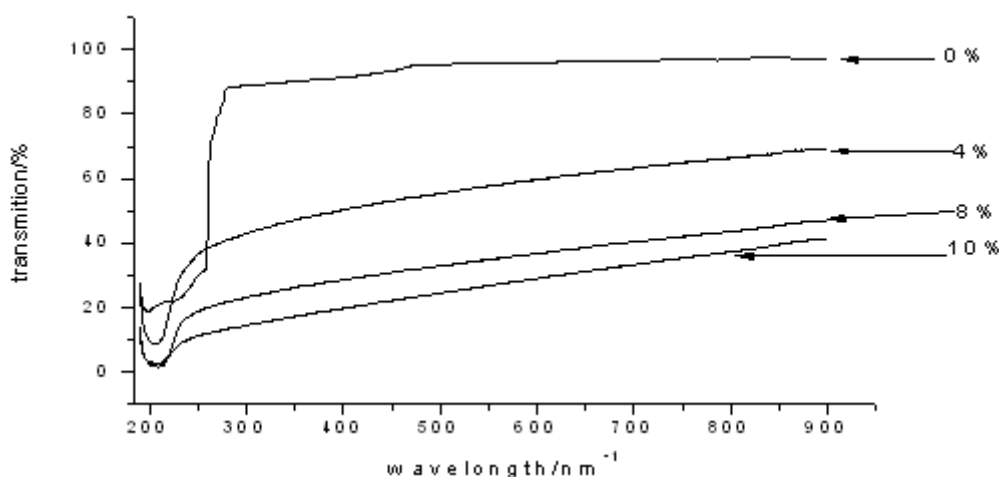
1138cm⁻¹ absorption peak results from Antisymmetry expansion and contraction vibration of Si-O-Si. It is very clear to see from the picture that 812 cm⁻¹ Si-O-Si Symmetrical expansion and contraction vibration peak and 459cm⁻¹ Si-O-Si bending vibrations absorption peak. Compared to SiO₂ and PVB spectrogram, peak position is not changed obviously. It is said that the speciality of SiO₂ and PVB is existing in PVB/ SiO₂ compound material. So the chemical bond occurs unlikely. At 1100cm⁻¹~1180 cm⁻¹ circular Si-O-Si bond absorption peak is higher than pure SiO₂. It could mean SiO₂ which is in compound material may form reticulation structure in PVB. With SiO₂ increased content, it accelerates the network structure formation which is centered by SiO₂. And the PVB/ SiO₂ composite materials show good performance in

UV shielding and toughness these two areas.



Picture 2. PVB/SiO₂ X-ray diffraction collection of illustrative plates of the compound material

Picture 2 is the PVB/SiO₂ X-ray diffraction collection of illustrative plates of the compound material, because both pure PVB and pure SiO₂ belong to amorphous aggregation state structure, it's X-ray diffraction picture respectively show a diffusion broad diffraction peak at 2 theta angle 19° and 23°. After PVB/SiO₂ compound material formed, a more spacious diffusion diffraction peak appear at 2 theta angle 18°~27°, After 2 theta angles 45°, even curve appears, which indicates compound material is not only crystalline state, and there is also long-range structure to some extent.



Picture 3. Ultraviolet light transmittance map

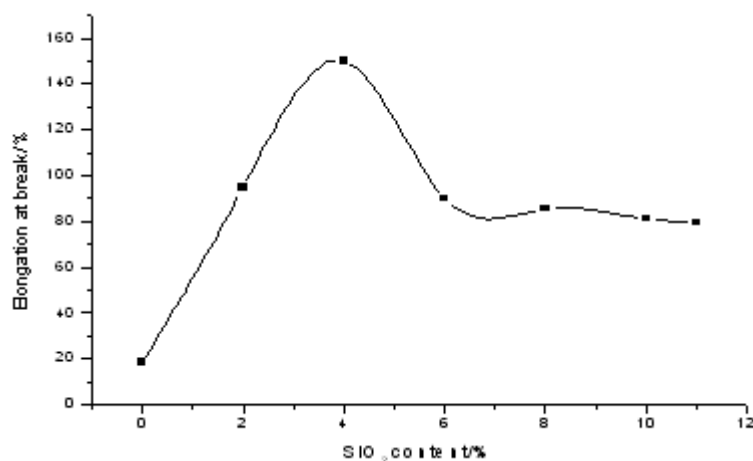
3.2 Compound materials ultraviolet absorption spectrometry analyses

Picture 3 demonstrates the PVB/SiO₂ compound material and visible spectrum with different SiO₂ contents., From the picture, pure PVB material can hardly screen ultraviolet 290 nm ~ 400 nm (curve a), , and within 240 nm vicinity range there are still certain degree permeates ($T \approx 24\%$), This means this material can not only screen ultraviolet from 290 nm to 400 nm, but is also poor at screening ultraviolet with high energy. Therefore, the pure PVB film can not screen material covered by it from the

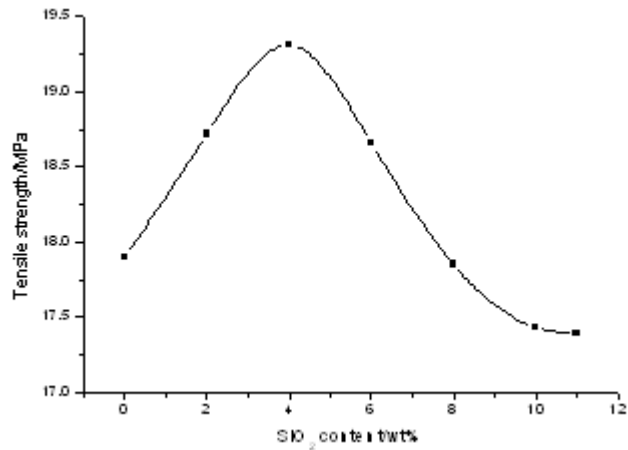
destruction of ultraviolet effectively. After the formation of PVB/SiO₂ compound material, the rate of permeation is really low around 240nm (<9%), what's more, the effect of screening is better between 290nm to 400nm. when SiO₂ is 4 wt %, about 40 % ~ 50 % ultraviolet can be screened away.. With the rising of material with SiO₂, the effect of screening off ultraviolet becomes better and better. It can be seen from it that after SiO₂ disperses homogeneously to PVB material, its characteristics of absorbing ultraviolet is brought into full play. Besides, in 400 nm ~ 800 nm visible light, material has demonstrated higher transparency. Therefore, institute preparation PVB/SiO₂ nanometer compound material has the fine ultraviolet glossy shield characteristic. Therefore, prepared PVB/SiO₂ nanometer compound material has the fine ultraviolet glossy shield characteristic; moreover, its transparency is fairly good in visible light area[8].

3.3 The mechanical properties of composite materials testing analysis

It can be known from picture 4, if we put SiO₂ particle into PVB, the tensile strength increases with the silica content increasing. It will reach the max when the SiO₂ content is 4% and after that it will fall. The elongation at break of pure PVB material is only about 18.45%, performing a certain degree of brittleness. The yield phenomenon is not obvious when it ruptures. After the nanometer SiO₂ is put in the PVB, we observe necking contraction and Stress Blushing in tensile process obviously. The test specimen stretch cross section appears extremely their regular fold phenomenon. These tough characteristic is even more obvious along with the SiO₂ content increase. In SiO₂ content when 5%, the break elongation ratio reaches the maximum value, also for pure PVB 7 - 8 times. Later gradually will reduce along with the SiO₂ quantity increase, and flatten out, but pure PVB was still higher than 3 - 4 times. At the same time, in the break elongation ratio maximum value place, the longitudinal strength also reaches the maximum value. This is because nanometer SiO₂ has the high active surface, intensely was adsorbing the PVB molecular chain, between the PVB member chain and the SiO₂ granule has formed the effective physical effect network. This net plays the even distributed load role in the pulling test process, reduced has had the break possibility, thus caused the compound material the break elongation ratio large scale enhancement, enable the longitudinal strength also to have the certain degree improvement.



A. Compound material break elongation ratio



B. Compound material longitudinal strength

Chart 4. SiO₂ content and PVB/nano- SiO₂ compound material mechanics performance test chart

4. NEW NANOMETER COMPOUND MATERIALS IN ENVIRONMENT DESIGN APPLICATIONS

4.1 The Application of Transparent Materials on Environment Design

With its rich nature, refine, transmission, reflection and refraction, light becomes a quite important factor on construction environment design. When blended with transparent materials, it creates perfect decoration effect, therefore gets peoples' favor.



Chart 5. Japanese state-run new art museum

Dated from New Babylon Dynasty, glass appears in the form of glaze tile, taking the role of shell and

bitumen to be the main surface decoration materials in that time. On modern construction, decoration with glass becomes a fashion. Being used to decorate the door and window, glass plays the function of partition, meanwhile it is provided with advantage of wind-against, rain-proof, skylight and perspective. On form, part or whole glass is adapted. As showed in Picture 5, Japan Nation's New Gallery which was designed by famous Japanese architect has the glass curtain wall. It is elegant and with tension in external feature, capacious and unobstructed in internal space. The transparent feature of glass is interpreted completely. With its fine previous to light, glass is applied to the light fixtures and light screen.

Glass itself is transparent with no color. But treated by the new techniques such as melting, casting, lining, gluing and gripping will displays the different sense of reality. The environment created for the room inside and outside has been insightful, brightly, the multi-colored decoration effect. But, the people while enjoy the glass the rich visual feeling which brings to the people, also light contamination concern and silently withstanding ultraviolet ray, the pain and the worry which brings to the people.

4.2 Light pollution to human body injury

The light pollution is refers to the modern society to produce excessive or not the suitable ray radiation, creates to the human life and the production environment not good affects. According to the light wave length it may divide into the ultraviolet ray pollution, the infrared light pollution and the laser pollution and so on. The main injury of the ultraviolet ray to the human body is the eye cornea and the skin. The wave length which is in 250 ~ 305nm may create the eye cornea damaged, may cause the eye to create one kind to call the fear light ophthalmia the side pain keratol eukoma injury. Besides severe pain, but also often causes to burst into tears, the eyelid convulsion, the eye cornea hyperemia and the eyelash shape twitches and so on. The wave length which is in 280 ~ 320nm and 250 ~ 260nm partial may create the skin the damage, mainly is causes the red spot and the urine blister. It is serious when can cause the epidermis necrosis and shed skin. The infrared to the human body injury is also the eye and the skin. The wave length which is 7,500 ~ 13,000 Egypt's part, may create the eye ground retina injury. The person eye if exposes for a long time to the infrared possibly causes the cataract. A stronger infrared may cause the skin damage. The situation is similar with scalds. At first it is burningly painful, then creates the burn.

The people not only can receive the harmful light in the natural environment the radiation, similarly also has the light contamination concern in very many artificial environment, such as in ballroom, bar and so on. The black light lamp which produces the ultraviolet ray intensity is higher than in the sunlight by far the ultraviolet ray intensity, also the duration to the human body harmful influence to be longer. The people if accept this kind of illumination for a long time, may induce to flow the nosebleed, to escape the tooth, the cataract, even causes the leukemia and other canceration.

Therefore, in the environment design light contamination should be concern by the environment designer doublely.

4.3 Nanometer compound materials may effectively solve in the glass construction environment ultraviolet ray contamination concern

The PVB/SiO₂ nano-composite has not merely good shielding effectiveness of ultraviolet light and infrared light, but good perspectivity within the range of visible light region. Therefore, when PVB resin is applied to the laminated glass, the outer wall in the architectural design as well as various lamps and lanterns, it has good shielding effectiveness of ultraviolet and infrared rays. In this way, the problem of light pollution can be solved.

5. CONCLUSION

1ST. Infrared spectroscopic analysis indicates that the inorganic nanometer SiO₂ particle has already been grafted to the polymer PVB. X-ray diffraction analysis indicates that PVB/SiO₂ nano-composite is amorphous, and the long chain structure macromolecule still exists. Ultraviolet transmissibility analysis shows that the introduction of nanometer SiO₂ particle could strengthen the ultraviolet shielding property of the PVB / nanometer SiO₂ composite.

2ND. Stretch analysis indicates that when SiO₂ particle is added into the PVB, the mechanics property of the material could be changed. This could improve the toughness of the material, and the breaking elongation of the material is greatly improved at the same time. Maximum breaking elongation appears when the TiO₂ content accounts for 4%, and the tensile strength also reaches a maximum value, which is 6-8 times that of pure PVB. The tensile strength would gradually reduce until it becomes stable, but still 3-4 times higher than pure PVB. The poly vinyl butyral (PVB) itself has filming nature. It can form film without adding plasticizer.

3RD. Prepared PVB/SiO₂ nano-composite has good ultraviolet shielding property and good transparency clarity in visible spectra area. When applied to laminated glass, outer wall glass as well as various lamps and lanterns, PVB resin could have good shielding effectiveness of the ultraviolet ray and reduce the light pollution caused by ultraviolet ray.

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