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Fabrication, characterization. multilayer transparent Wood. different species

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Abstract: [Objective]Multilayer Transparent Wood. laminated transparent woods(. Same direction Or cross direction?) Under Vacuum. This will greatly reduce. anisotropy. Transparent Wood. [Method]This study explored. process. making three,. tree species. different densities: Balsa(0. 21 g/cm3)Paulownia(0. 33 g/cm3), Basswood(0. 49 g/cm3)And tested their delivery and tens Properties.In order to produce,The Lamination method was endorsed.The mechanical properties and transmission of single layer and multilayer Transparent Wood with the same thickness were compressed.[REsult]Compare their similarities and differences,Balsa wood has the small density and contains more space inside,Which is easier to remove lignin and impersonate resident.There were many active in Paulownia(8. 9%),Hence it needs to be recognized in Sodium Hydroxide(NaOH)To remove active and open the blocked bits.The Density of basswood was 0. 49 g/cm^{3},Which Used lignin difficult to remove,But its Tennessee property was good.Steps the influence of Tree Species,The thickness had a great influence on Transparent Wood.. Thicker. wood.. Greater. difficulty. removing lignin... Properties. Transparent Wood combined. same direction. closer. original Transparent Wood.However. Transmission. Transparent Wood combined. cross direction. lower. original Transparent Wood.But. difference ~ transverse, longitudinal stretch had. narrowed.[Conclusion]Our study widens. selection. Transparent Wood Species, makes it possible. Transparent Wood. high thickness, low cost.

Keywords:Multilayer Composite;Transparent Wood;Delignification;Transmission;Stretch Property

1. Materials and Methods

1.1.Material

Balsamu was purchased from Yunnan Province,5.Year-old, natural drying, moisture content10. 7%, Density0. 21 g/cm^{3}.Paulownia was purchased from Henan Province,7.Annual, moisture content11. 3%, Density0. 33 g/cm^{3}.Basswood purchased from Russia,10The moisture content is12. 1%, Density

0.49 g/cm^{3}.Transparent epoxy resin and curing agent are manufactured by Wenzhou tailsy Company.Chemicals (sulfuric acid,Sodium chlorite,Sodium hydroxide,Acetic acid) is provided by Shanghai Aladdin Biochemical Technology Co., Ltd. distilled water is produced in the laboratory.0.2.Determination of Lignin and extracted components in wood

Adopted literature [14.S. Pulp and Paper Industry Technology Association (Tappi)Standard Method for Determination of the mass fraction of Lignin and benzene alcohol extracts.The volume ratio of benzene to ethanol2 1.Repeat by test3.Sub-average.

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1.3 Lignin Removal

Configuration2%Sodium chlorite ($NaClO_2$)Solution, using acetic acid buffer willPHValue4. 6, Using a centralized heated constant temperature Heating magnetic stirrerDF-101SHeated80, Put in the wood.1.,2.And5.

The removal time of lignin from thick balsama is4.,6.And12 h.1.,2.And5mmThe lignin removal time was6.,8.And 16 H.0. 5,1.,2.And5mmLignin removal time of thick basswood 5.,8.,14.And22 h.And then I put the wood chips5 mol/LHydrogen peroxide solution (H_2O_2)Heated90Processing1 HTo suppress Yellowing of sliced wood.

1. 4 Preparation of Transparent Wood

Before impregnation, remove lignin into anhydrous ethanol solution

Displacement of its internal moisture, which will greatly enhance the penetration of wood

Sex.The ratio of epoxy resin to curing agent is3.:1.,

Acetone ratio is1.:1..In the same or staggered direction, the multi-layer lignin-removal wood slices were put into the impregnating liquid, using a vacuum drying box (DZF-6020)Impregnation under pressure1 kPa, Dipping time2 hTo prepare Transparent Wood and cross-laminated Transparent Wood.Then dry naturally24 hWaiting Resin Curing.Preparation Process as shown in Fig.1.Shown.

From figure4In can see maximum of transmittance in certain of off lignin time after it change small so can think this kind of methods under get of Transparent Wood of transmittance is have limit.And its to maximum transmittance of time also with the thickness of increase and extend.1mmWhen only need4 hOf off lignin processing after impregnated can reach maximum transmittance and2mmNeed6 h.This (thickness is influence Transparent Wood off Lignin of Main Factors.Thickness

Big off Lignin of difficulty the greater the energy of consumption also the serious.By test get a good5mmThick off lignin wood chips need to processing12 hAnd layer5Tablets1mmThickness of Transparent Wood off lignin processing only need4 h.With the thickness of increase Transparent Wood of transmittance decreased trend.1,2,5mmThickness of single-layer transparent balsa of transmittance respectively82%,75%And64%.The single-Transparent Wood of the transmittance the is good performance

It is that the mechanical properties of their transverse and smooth lines are quite different..As shown in Fig.5.As shown:The tensile strength limit of the grain is the tensile strength limit of the grain.11Times.In order to reduce the anisotropy of Transparent Wood, we made transparent wood with high thickness by laminated Transparent Wood.

Transmission test and Tensile Performance Test..Figure6.Yes Will1mmThe Thick Transparent balsamas are layered in the same direction or in the same direction.2.,5.,10mmTransmittance of thick, multi-layered Transparent Wood.

Single-storey original balsamuSingle Layer original balsa wood(Obw);Single-storey transparent balsamuSingle Layer transparent balsa Slave chart5.6.Can be seen in:In the same direction, the transmittance and tensile limit of transparent barsha wood are similar to those of single barsha wood with the same thickness;When crossing layers, the double transparent balsambi2mmThick single-storey transparent balsamu low4%But the stretching limit of the stripes varies from181. 24 NAscend1 085. 74 nAnisotropy has been eliminated.The transmittance of the transparent balsamic wood with five layers can be reached.54%The transmittance of ten-storey cross-laminated transparent balsamic

31%.At Wavelength320~400 nm(UVA)In the stage, the transmittance of all transparent balsamic trees dropped rapidly.UVAIt is a kind of ultraviolet radiation that can destroy the human epidermis and induce the cancer of human cells.

Line.Transparent Wood has obvious filterability in this wave, so transparent wood can be used as shading material in the field of intelligent building..

2.3.Preparation and Characterization of transparent Paulownia

Use0. 3%Sodium hydroxide soak24 hProcessing can improve Bonding Properties of Paulownia with epoxy resin.Pretreatment with sodium hydroxide solution will cause many pores in the wood slices, resulting in larger intercellular spaces and increased intercellular pores..This is due to the swelling effect of sodium hydroxide solution on

cells and the migration of hydrophobic extracts..It is believed that the porosity, cell wall thickness, plasticity and surface area of the veneer pretreated with sodium hydroxide solution increase, which is beneficial to

Permeation and interfacial bonding of oxygen Resin Solution.Slave chart7.You can see:Without0. 3%Sodium hydroxide treated2mmThe transmittance of Thick Transparent Paulownia is only19%The transmittance of the treated clear Paulownia can be73%.Will two layers1mmThick Paulownia Wood in the same direction or cross layer together, make double layer in the Same Direction transparent Paulownia Wood and double layer staggered transparent Paulownia Wood.

Single transparent PaulowniaSingle Layer transparent paulonia wood(Sltpw);The same direction layer of through the bubble Tong woodSame Direction multilayer transparent paulownia Wood(Smtpw);Make split-level of transparent Paulownia WoodCross Direction multilayer transparent paulownia Wood(Cmtpw).

From figure7/In can see:With the Paulownia Wood Chips thickness of increase transmittance decreased of trend.1mmThickness of transparent Paulownia Wood transmittance can achieve80%2mmThickness of transparent Paulownia Wood transmittance

For73%5mmThickness of transparent Paulownia Wood transmittance45%.And layer of the double-layer in the Same Direction transparent Paulownia Wood transmittance can achieve71%Close2mmThickness of single-layer transparent Paulownia Wood.Double-Layer staggered transparent Paulownia Wood of transmittance67%Slightly lower than single-layer transparent Paulownia Wood.From

8Of mechanical analysis:Impregnated Epoxy Resin for grain orientation of tensile strength increase don't obvious even also slightly lower than not until the maceration of Paulownia Wood.This may be because pretreatment Paulownia Wood Chips when sodium hydroxide

The original closely combined with the fiber structure the damage.But transverse orientation of mechanical performance is the original Paulownia Wood improve the many tensile strength

0. 98 MPaImprove3. 39 MPaDrawing Die of from15. 11 MPaImprove32. 75 MPa.Double-Layer staggered2mmThickness of transparent Paulownia Wood eliminate the transverse and longitudinal of difference between its tensile strength

05 MPaDrawing Die of266. 67 MPaThis much higher than in single-layer transparent Paulownia Wood of Transverse Mechanical Performance.Comprehensive on the double the same direction transparent Paulownia Wood and single-layer transparent Paulownia Wood of transmittance and mechanical performance more similar and Double Staggered transparent Paulownia Wood of transmittance slightly lower, but its advantages is great improve the transverse tensile of mechanical performance and then reduce the transparent wood of the to the opposite sex.

2.4Transparent basswood of Preparation and Characterization

In this study in due to white basswood density is big(0. 49g/

Length^3)When wood chips thickness1mmWhen lignin removal time8 hFor3Of species the most long.1,2And5mmThickness of Transparent white basswood transmittance respectively70%,46%And11%Were lower than the other two kind of tree species.Thus it can be seen that,1mmThickness of white basswood not suitable for the production layer of Transparent Wood.So the off lignin time5 HTransmittance up80%Of0. 5mmOf rotary cut white basswood the layer of and the single-layer,The same direction double-layer,Staggered Double-Layer,Staggered three-layer of style Production of Transparent white basswood the Tensile Performance of analysis.

As shown in figure9,10Shown in:To0. 5mmThickness of white basswood for raw material production of Transparent white basswood its transmittance with the layers of increase and drop

Low.Single-layer transparent white basswood,The same direction double-layer transparent white basswood,Staggered double-layer transparent white basswood,Staggered three-layer transparent white basswood of transmittance respectively80%,75%,67%And55%.The same direction double-layer transparent white basswood than staggered double-layer transparent white basswood of transmittance higher may because the same direction layer when the texture orientation more close to native wood of Texture.But

Make split-level of can eliminate Transparent Wood of transverse heshun with Tensile Performance of difference.Single-layer when along with tensile strength and Drawing Die of respectively is transverse12Times and19Times.Pay to split-level of the transverse and along with the Tensile Performance almost no difference.The same direction double Paulownia Wood of along with tensile strength and Drawing Die of respectively49. 36And1 264. 32 MPaTransverse tensile strength and Drawing Die of respectively4. 55And95. 58 MPaWere higher than that of single-layer transparent white basswood.Staggered three-layer transparent basswood of Tensile Performance to lift maximum transverse tensile strength to33. 21 MPaIs single-layer transverse tensile strength11Times.Along with tensile strength can reach65. 23 MPaDrawing Die ofl 635. 08 MPa.

2.5Species density and transmittance and tensile strength of relationship

Balsa,Paulownia Wood and white basswood of density respectively

0.21,0. 33And0. 49 g/cm^3.From figure11In can see:When wood chips thin when density for transmittance of influence is small transparent Barr

Shamsi and white basswood of transmittance difference12%But when thickness increase5mmWhen transparent balsa and white basswood of transmittance differences.53%.So in production density is tree of an arcane should be take layer of is thin layers of style to save cost and improve transmittance.

Single-layer transparent white basswood of along with tensile strength can reach50. 86 MPaSingle-layer transparent balsa of along with tensile strength45. 66 MPa(Species density increase tensile strength also will enhance but amplitude not.This may be because density big of species difficult to remove the lignin epoxy resin failed to fully and off lignin template combined with lead.And Paulownia Wood because after the sodium hydroxide of impregnated strength reduce its arrange

With tensile strength is only30. 59 MPa.

3. Of On

1)Species different its density and components content are different so preparation methods different.Preparation transparent balsa required off lignin time shortest,1mmThickness of transparent balsa transmittance highest

82%Along with tensile strength increase to logs6Times.Preparation transparent Paulownia Wood need to first remove the extraction of to extraction of after1mmThe transmittance of Thick Transparent Paulownia can be reached80%But the tensile strength will drop.The longest time required for the preparation of basswood is to be understood,1.

Thick and clear, the transmittance of basswood is only70%But its tensile properties are the best.

(2.)The laminated method can save energy consumption in the delignin stage caused by the increase of wood thickness, and reduce the harmful substance chlorine.

Column of three tree trees with different identities

Generation of gas.

3.)Transparent Wood also has the characteristics of wood anisotropy. The cross-laminated method can eliminate the difference between the transverse tensile properties and the longitudinal tensile properties..

In the future research, we will explore the bonding mechanism between the resin and the lignin removal template during the impregnation process, and further study the factors affecting the transmittance and mechanical properties of multilayer Transparent Wood, transparent Wood with higher transmittance and stronger Load Capacity.

References

1. Guan Ning."Transparent Wood"[J].International Wood Industry,2017,47(5.):17.Guan n. Wooden glass for Windows and solar panels[J].International Wood Industry,2017,47(5.):17.
2. Wu Yan, Wu Jiamin, Tang caiyun, *et al*.Transparent Wood Preparation Method: Cn106243391a[P].2016-12-21. Wu y,Wu J m,C Y, Tang,Et al.Production Method Transparent timber:Cn106243391a[P].2016-12-21.
3. Fink s.Transparent Wood:A new approach. Functional study. Wood structure[J].Holzforschung199246(5):403--408.
4. Yu Z YYao Y JYao J NEt al.Transparent Wood containing CS_XWO_3Nanoparticles. heat-shielding window

applications[J].Journal. Materials Chemistry20175(13):5963--6330.
5. Zhu M WLi TDavis C SEt al.Transparent, Haze Wood Composites. highly efficient broadband light management. Solar Cells[J].Nano Energy201626:332--339.
6. Li Jian Gan Wentao high li kun and.A kind of fluorescence transparent magnetic wood of preparation.Method:CN106313221A[P].2017--01--11.Li JGan W tGao L KEt Al.Manufacturing method.Fluorescent Transparent Magnetic Wood:CN106313221A[P].2017--01--11.
7. Li YYu SVeinot J G CEt al.Luminescent Transparent Wood[J].Advanced Optical Materials20175(1):1600834.
8. Gan W t[S LGao L KEt al.Luminescent, transparent Wood Composites Fabricated by poly(Methyl Methacrylate)AndGamma-Fe2.O3.@Yvo:EU^{3}·NanoparticleImprovement[J].ACSSustainable chemistry&Engineering,2017,5.(5.):3855--3862.
9. Li Y,Fu Q L,ROjasR,Et al.Lignin-receiving Transparent Wood[J].Chemsuschem,2017,10(17):3445--3451.
10. Yaddanapudi h s,Hickerson n,Saini s,Et al.Fabrications and Characterization of Transparent Wood for next generation smart building applications[J].Vacuum,2017,146:649--654.
11. Zhu m W,Song J W,Li t,Et al.High anistropic,High Transparent Wood Composites[J].Advanced Materials,2016,28 (26):5181--5187.
12. Li Y,Yang X,Fu Q L,Et al.Towards centermeter tick Transparent Wood through interface manipulation[J].Journal of Materials Chemistry,2018,6.(3.):1094--1101.
13. Fang Lu, Chang Liang, Guo wenjing, *et al*.HDPEPerformance Comparison of plywood and Urea-formaldehyde Resin Plywood [J [J].Journal of Beijing Forestry University,2014,36(2.):125--128.
14. Yokoyama TKadla J FChang H M.Microanalytical method. characterization. Fiber Components, morphology. Woody plants[J].Journal. agricultural, Food Chemistry200250 (5):1040--1044.
15. Gan W tGao L K[S LEt al.Transparent magnetic wood Composites Based. immobilizing Fe_3O_4 Nanoparticles. Delignified wood Template[J].Journal. Materials Science201752(6):3321--3329.
16. Yuan jinxia wei huang xian south and.Two of Paulownia raw materials and Pulping Performance Study [J]., China Paper,201635(7/):83--85.
17. Weeks yi tong chang xiao li tension flat.Lignin of Structure and Its Modified present situation [J]. Modern Chemical,201030(S2):63--66.
18. Dolk m,Yan J F,McCarthy J. L..Lignin 25.Kinetics of hierarchy of western hemlock in flow-through reactors under alkaline conditions[J].Holzforschung,1989,43(2.):91--98.
19. Dr. Wu, Zhang Xun, Yang Jun, *et al*.Study on the dissolution mechanism of lignin in the cell wall of Chinese Fir pretreated by chlorite [J [J].Forest chemistry and industry,2017,37(3.):38--44
20. Li, Bai xuetao.Effects of ultraviolet radiation on human skin health [J].Foreign Medical hygiene register,2008,35(4.):198-202.
21. Chen Yuhe, Huang Wenhao, Chang DeLong, *et al*.Study on the Effect of Sodium Hydroxide pretreatment on wood bleaching [J].Forest chemistry and industry,2000,20(1.):52--56.
22. Li Jian Ge b·bmingyu.Sodium hydroxide solution pretreatment Improve cementation strength mechanism of study [J].Northeast Forestry University Journal,199018(1):80--87.