

Article

Effect of Resin Content on the Surface Wettability of Engineering Bamboo Scrimbers

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Abstract: Bamboo scrimber refers to a lignocellulosic structural material, which is usually attacked by water, ultraviolet radiation and fungus. Surface coating is an effective way to protect it, and its coating properties depend on surface wettability. In this study, the surface wettability of bamboo scrimbers with varying resin content was investigated via the comprehensive analysis of surface roughness, surface contact angle, surface free energy, surface chemical composition and coating properties. The resultant scrimbers had a similar profile with low roughness. Their surface was hydrophilic, but the hydrophilicity decreased with the increase in resin content. High resin content gave rise to low total free energy, in which the Lifshitz–van der Waals component was dominant and it decreased with the increasing resin content. Meanwhile, the ratio of the electron-accepting component to the electron-donating component becomes higher. This was due to the decreasing hydrophilic groups (e.g., -OH and -COOH groups) and the increasing oxygen-free groups (e.g., C-H and -CH₂ groups) on the scrimber surface. The resin content affected the adhesion by decreasing the surface wettability, but the coating adhesion still reached the level of 2 for all bamboo scrimbers. The results will provide a theoretical reference for the surface coating of bamboo scrimbers in the structural application for good coating durability.

Keywords: bamboo scrimber; resin content; surface free energy; chemical composition; coating adhesion



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1. Introduction

Net carbon storage materials have attracted great attention in structure because of the growing climate crisis [1]. Among them, bamboo scrimber refers to an engineering material that is processed by assembling long bamboo fiber bundles with phenol-formaldehyde resin into a dense block [2]. The process retains the natural characteristics and orientation of bamboo fibers, which endows bamboo scrimbers with excellent mechanical properties [3,4]. For instance, the scrimbers made of Ci bamboo (*Neosinocalamus affinis*) with a density of 1.30 g/cm³ and resin content of 13% yielded 398 MPa in the modulus of rupture (MOR) and 32.30 GPa in the modulus of elasticity (MOE) [5], which were much higher than many selected bamboo/wood-based structural materials [6]. Moreover, the scrimbers have remarkable water resistance and dimensional stability [7]. They have naturally been widely used for floors, furniture, buildings, and even in high-end applications such as wind turbine blades [8]. However, they are lignocellulosic composite materials, which are susceptible to discoloration, biological attack and degradation, particularly in outdoor conditions, affecting the performance and durability [9,10]. A generic solution is to cover their surfaces with coatings, which can effectively prevent them from being exposed to the air [11,12].

The coating adhesion is highly related to surface wettability [13,14]. Wettability is a general term to describe the bonding phenomenon of a liquid contacting a solid surface [15]. It regulates the quality of mechanical interlocking, molecular-level interaction and secondary force interaction between the coating film and the coated surface [16]. Supposing that an unsatisfactory wetting interface formed before a coating cured, there would be weak adhesion on the interface, which was bound to bring about poor coating durability [17]. Thus, the surface wettability of bamboo scrimbers should be identified before coating.

In general, surface wettability is assessed by the contact angles of liquids on the surface [18]. If the contact angles are less than 90° , the liquid can wet the given surface, and the smaller the contact angle, the better the wettability [19]. If the angles are larger than 90° , the liquid does not wet the surface [20]. The contact angles are closely related to surface chemistry and geometry [21,22]. Chemical composition is one of the important factors because it is greatly involved with the molecular interaction between liquid and solid [23]. Lignocellulosic materials are usually hydrophilic because their main chemical components contain plenty of hydrophilic groups. Less hydrophilic groups from cellulose and hemicellulose existing on the surface give rise to worse wettability [24], where the surface free energy reduced with the decreasing ratio of oxygen to carbon (O/C) [25]. Moreover, the restructuration and exudation of extractives such as gum decreases surface wettability [26]. Surface roughness is another important factor affecting surface wettability. High roughness makes the hydrophilic surface more hydrophilic, while it makes the hydrophobic surface more hydrophobic [27,28]. Roughness depends on the material properties (e.g., density and porosity) and surface machining (e.g., sawing, planing, and sanding) [29,30]. Previous studies have found that high-density woody composites had low surface wettability and there is a strong correlation between the density and wettability [31,32]. Bamboo scrimber is a high-density composite composed of bamboo and phenolic resin, in which there are complex physical and chemical interactions between the two components. In addition, the phenolic resin acts as a barrier in the composite to prevent water from spreading and penetrating [33]. However, few studies were focused on the surface wettability of bamboo scrimbers, especially with different resin contents. Consequently, there is no available theoretical information provided for coating their surfaces.

In this study, the surface wettability of bamboo scrimbers with varying resin contents was evaluated by the contact angle method. The surface roughness, morphology and chemical composition were also investigated for a better understanding of liquid spreading and penetration on them. The coating adhesion was preliminarily tested by the surface scratch method. The study aims to investigate the effect of resin content on the scrimber wettability with attempts to reveal the mechanism.

2. Materials and Methods

2.1. Materials

Five-year-old fresh Ci bamboo with a diameter of 50–60 mm was collected from a natural forest in Sichuan Province, China. Phenolic resin with a solid content of 47.49%, a viscosity of 41 mPa·s at 25°C and a pH of ~ 10 was obtained from Dynea Guangdong Co., Ltd (Guangdong, China). Formamide and diiodomethane were of analytical grade and were purchased from Shanghai Aladdin Biochemical Technology Co., Ltd (Shanghai, China). Deionized water was obtained using Millipore Milli-Q system (China). Other chemicals were of reagent grade and were purchased from Shanghai Aladdin Biochemical Technology Co., Ltd.

2.2. Preparation of Bamboo Scrimbers

The scrimber samples were prepared according to the reported method [7]. In brief, fresh bamboo culms were cut into 200 cm-long tubes, divided longitudinally into two semicircle parts, and split along the grain by a tailored machine into fiber mats. The mats were cut across the grain into 30 cm-long pieces and dried in an oven at 103 ± 2 °C. The dried mats were impregnated with diluted phenolic resin and dried at 60 °C to a moisture content of approximately 10%. A certain weight of the impregnated mats was assembled along the fiber grain in the mold. Hot pressing was conducted at 145 °C for 30 min on a Model 3856 thermo-compressor (CARVER, USA) to obtain scrimber samples ($300 \times 200 \times 20$ mm³) with a density of 1.30 g/cm³. Four common resin contents (i.e., 9, 11, 13, and 15%) were used to obtain a series of scrimber samples.

The scrimber surface was sanded on an MM491GL wide-belt sander (LUXTER, China) equipped with 240-grit aluminum oxide sandpaper to smooth the surfaces. The sanded surface was pneumatically cleaned with a 0.75LE-835C air compressor (HITACHI, Japan) to remove the dust. The resultant samples were cut into the required dimensions and conditioned in a room at 20 °C and 65% RH for 2 weeks for further tests.

2.3. Measurement and Characterization

2.3.1. Determination of Surface Roughness

The cleaned surfaces were observed with a VHX-6000 ultra-high accuracy microscope (Keyence Corporation, China). The roughness was measured on a TIME 3230 profilometer (Beijing Time High Technology Co., Ltd., China) equipped with a skid-type diamond stylus. The cut-off length and tracing length were set to be 2.5 and 12.5 mm, respectively. The average roughness (Ra) and mean peak-to-valley height (Rz) were measured according to ISO 4287 (1997) [31]. The sample surface with 50×50 mm² was scanned by the stylus at a speed of 0.5 mm/s across the fiber grain.

2.3.2. Measurements of Surface Contact Angle

The contact angles of water on the samples were measured by the sessile drop method. The measurements were performed on a JC2000D contact angle analyzer (Xi'an Yima Opto-electrical Technology Co., Ltd., China) at 20 °C and 40%–50% RH. The constant contact angle change rate (*K* value) was used to quantitatively evaluate the wettability and it was obtained using the defined functions of the nonlinear regression model to fit the S/G model [34]. The model equation is presented as follows (1):

$$\theta = \frac{\theta_i x \theta_e}{\theta_i + (\theta_e - \theta_i) e^{[K(\frac{\theta_e}{\theta_e - \theta_i})t]}} \quad (1)$$

where θ_i is the initial contact angle, θ_e is the equilibrium contact angle, θ is the contact angle at a certain time and t is the wetting time.

2.3.3. Determination of Surface Free Energy

The surface free energy was evaluated by the Lifshitz–van der Waals/acid-base (LW-AB) approach [35]. The contact angles of water, formamide and diiodomethane on the scrimbers were used to calculate the total surface free energy γ_s , dispersive (or Lifshitz–van der Waals) component γ_s^{LW} , polar (or Lewis acid–base) component γ_s^{AB} , electron acceptor (or Lewis acid) component γ_s^+ and electron donor (or Lewis base) component γ_s^- [36].

2.3.4. X-Ray Photoelectron Spectroscopy (XPS) Test

An XPS test was performed on an AXIS Ultra spectrometer (Kratos Analytical Ltd., UK) with a monochromatic Al-K α X-ray source ($\lambda = 1486.6$ eV). The spectra covering a binding energy range of 0–1100 eV were collected at a pass energy of 100 eV and a resolution of 1.00 eV/step. The high-resolution spectra of C1s were recorded at a pass energy of 20 eV and a resolution of 0.05 eV/step. Due to the potential degradation of the surface during

X-ray exposure, the spectra were collected in the same order (survey and C1s) to make sure that the amount of exposure to X-rays was equivalent for all analyzed samples. The background subtraction (Shirley-type), peak integration, fitting and quantitative chemical analysis were conducted by XPS analysis software. The C1s peak at 285 eV was used to calibrate the binding energy scale. Binding energy values were given at ± 0.2 eV. Gaussian peak profiles were used for spectral deconvolution of C1s spectra. The components and corresponding binding energy positions are shown in Table 1 [37]. The oxygenated to unoxxygenated carbon ratio (C_{ox}/C_{unox}) was calculated by Equation (2) [38]:

$$\frac{C_{ox}}{C_{unox}} = \frac{C_{oxygenated}}{C_{unoxxygenated}} = \frac{C_2 + C_3 + C_4}{C_1} \quad (2)$$

Table 1. Classification of carbon peak components for woody materials.

Binding Energy (eV)	Symbol	Chemical Group
284.8	C1	C-C or/and C-H
286.5	C2	C-O
288.0	C3	C=O or/and O-C-O
289.2	C4	O-C=O

2.3.5. Infrared Spectroscopy Test

Fourier transform infrared spectroscopy (FT-IR) spectra were collected using a Nicolet Nexus 670 spectrometer (Thermo Scientific, USA) equipped with a Thermo Nicolet Smart Golden Gate MKII Single reflection ATR accessory. The bulk sample with a clean surface was placed on the diamond crystal and the spectra in the wavenumber range from 4000 to 400 cm^{-1} with a resolution of 4 cm^{-1} were collected after 64 scans.

2.3.6. Coating Adhesion Measurement

The coating adhesion of the scrimber surface was measured according to the standard ISO 2409–2013. Water-based (Product ID: A7101-68205) and oil-based (Product ID: A718-68025) wood varnishes were obtained from AkzoNobel Performance Coatings Co., Ltd (Shanghai, China). Three coating layers on the scrimber surface were manually brushed. The amount of surface application was approximately 190 and 270 g/m^2 for water-based and oil-based varnishes, respectively. The adhesion test was carried out using an across-cut knife with a 2 mm gap. An adhesion tape was pasted onto the center of the scratch and steadily peeled off. The varnishes along the intersections of the cuts were observed and the classification of 0–5 was made on the percentage of the detached area.

3. Results and Discussion

3.1. Surface Roughness

Sanding is typically used to obtain uniform surfaces prior to coating. The surface morphology of sanded bamboo scrimbers with varying resin content is shown in Figure 1. It was found that there were no obvious defects except for white flocculent structures on the sanded surfaces. The flocculent structures were composed of tiny shavings stripped from the scrimber surface by the abrasive paper. The scrimbers with low resin content had fewer shavings on the surface, which may be due to their high surface hardness.

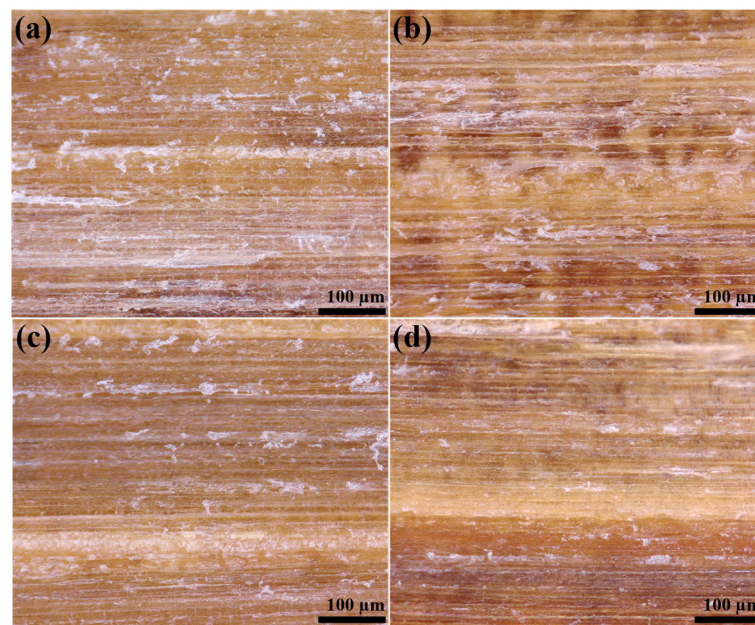


Figure 1. Surfaces of representative samples with different resin contents: (a) 9%, (b) 11%, (c) 13% and (d) 15%.

However, the flocculent structures seemed not to affect the surface roughness. As presented in Table 2, the average values of R_a and R_z had narrow distribution, and they ranged from 2.04 to 2.25 μm and from 13.09 to 14.30 μm , respectively. Surface roughness is heavily dependent on material density and surface machining [29,30]. In this study, all scrimber samples had a similar density and their surfaces were sanded in the same processing condition. In addition, the ANOVA analysis showed that there was no correlation between the roughness and the resin content ($p > 0.05$). Therefore, there was little difference in surface roughness between bamboo scrimbers with different resin contents.

Table 2. Surface roughness of bamboo scrimbers with different resin contents.

Resin Content (%)	Density (g/cm^3)	R_a (μm)	R_z (μm)
9	1.32 (0.02) ¹	2.25 (0.22)	14.30 (1.40)
11	1.31 (0.02)	2.23 (0.16)	13.96 (0.82)
13	1.30 (0.02)	2.04 (0.08)	13.09 (0.08)
15	1.30 (0.02)	2.14 (0.25)	13.49 (1.70)

¹ The figure between parentheses is the standard deviation.

3.2. Surface Wettability

The contact angles of water on the scrimber surface as a function of time are shown in Figure 2. The contact angles for each sample were less than 90° , suggesting that bamboo scrimbers possessed a hydrophilic surface. The instantaneous contact angles on the scrimber with high resin content were larger than those with low resin content, which indicated that more phenolic resin made the scrimber surface less hydrophilic.

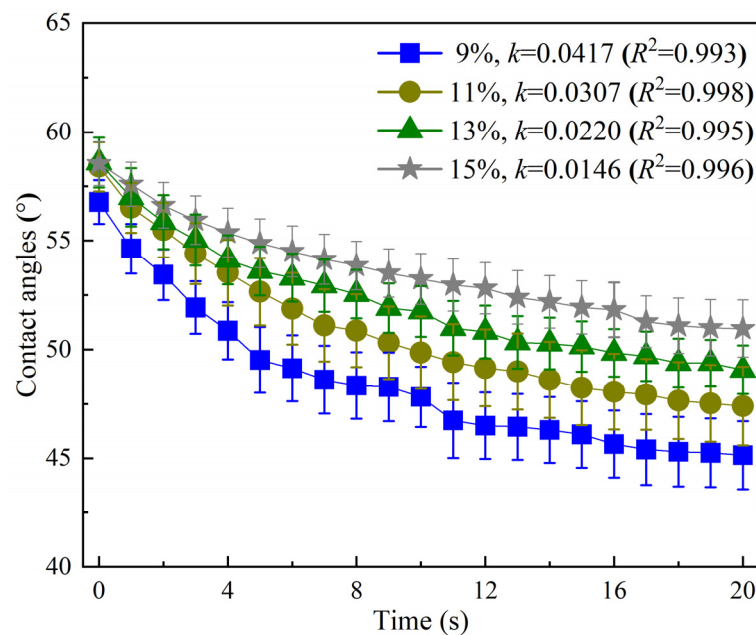


Figure 2. Contact angles of water on the scrimber samples with varying resin content.

For the scrimbers with low resin content, the contact angles reached equilibrium more quickly because of the larger K value. The physical meaning of the K value represents how fast the liquid wets the porous structure of wood-based materials [39]. In theory, the higher the K value, the faster the contact angle reaches equilibrium, and the faster the liquid spreads and penetrates [34]. As shown in the figure, the K value was 0.0417 for the scrimbers with a resin content of 9%, which was much higher than those of other scrimbers. In addition, the K value decreased as the resin content increased, which suggested that high resin content hindered water spreading and/or penetrating on the scrimber surface.

3.3. Surface Free Energy

The surface free energy of bamboo scrimbers with different resin contents is depicted in Figure 3. The total surface energy γ_s decreased with the increasing resin content (Figure 3a). The component γ_s is composed of the Lifshitz–van der Waals component γ_s^{LW} and Lewis's acid–base component γ_s^{AB} . The component γ_s^{LW} is dominant to the total surface energy, which arises from the hydrocarbonate backbone in cellulose, lignin and phenolic resin [28]. The hydrophilic C=O, -COOH and -OH groups provide the surface energy with polar components, which are responsible for woody surface wetting with polar solvents and the compatibility of woody materials with adhesives and paints [19]. The dominating contribution of the polar component is the component γ_s^{AB} due to the electron-donor properties of double carbon bonds, hydroxyl, and carbonyl groups [35]. As more phenolic resin was used in bamboo scrimbers, the component γ_s^{AB} increased while the components γ_s^{LW} reduced. However, the increasing component γ_s^{AB} was the leading factor of the increase in γ_s because the ratio of $\gamma_s^{AB}/\gamma_s^{LW}$ exhibited an increasing trend.

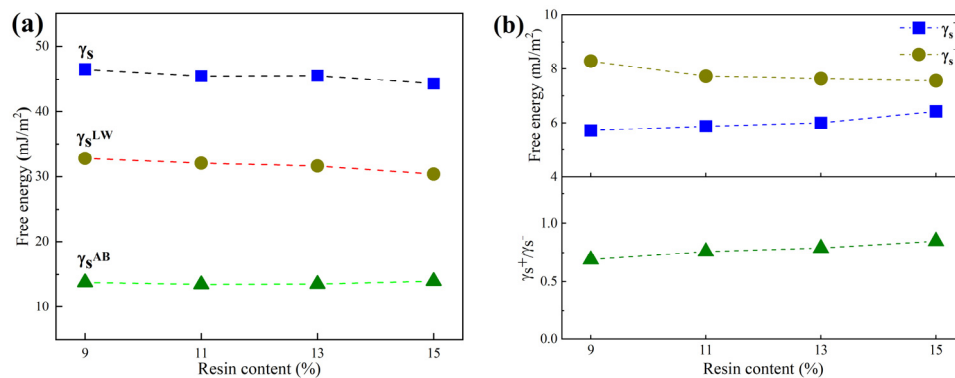


Figure 3. Surface free energy of bamboo scrimbers as a function of resin content: (a) γ_s , γ_s^{LW} and γ_s^{AB} ; (b) γ_s^+ , γ_s^- and γ_s^+/γ_s^- .

The acid-base contribution comprised two components: the electron acceptor component γ_s^+ and the electron donor component γ_s^- . As shown in Figure 3b, the component γ_s^+ increased with the increasing resin content, but the component γ_s^- was the opposite. The component γ_s^+ determined the change in the acid-base component because the ratio of γ_s^+/γ_s^- shared an increasing trend with the component γ_s^+ . The evolution of the different components of surface free energy can be explained by surface geometry and chemistry. As discussed previously, the surface roughness of all bamboo scrimbers was the same with a very low value and it had little influence on the surface wettability. Therefore, the surface chemical composition is a major determinant of the change in surface free energy.

3.4. XPS Analysis

XPS analysis is an effective technique to characterize the surface chemical composition of wood-based materials [40]. Two elements, carbon (C) and oxygen (O), were found in the spectra of bamboo scrimbers, and they were the basic components of wood-based materials [41]. Figure 4 shows the high-resolution spectra of XPS C1s with their deconvolution into three components.

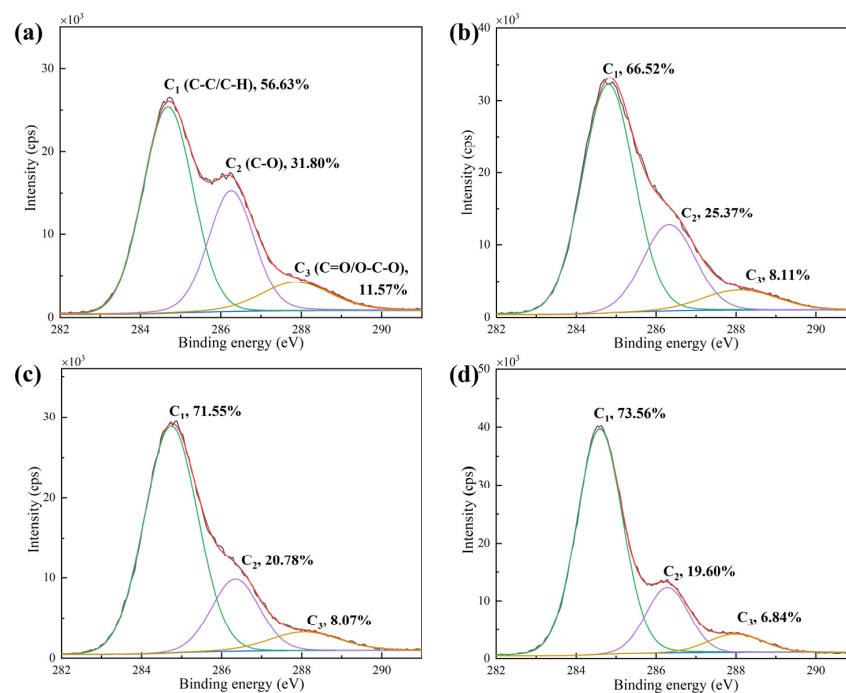


Figure 4. C1s spectra of bamboo scrimbers with different resin contents: (a) 9%, (b) 11%, (c) 13% and (d) 15%.

The C_1 peak, which was related to the C-C/C-H groups, mainly arose from phenolic resin and lignin in bamboo. The C_2 peak, representing the C-O groups, was from bamboo compositions, predominantly from cellulose. The C_3 peak, corresponding to the C=O/O-C-O groups, was assigned to hemicelluloses and cellulose [42]. C_1 and C_2 were the main components of bamboo scrimber surfaces, and they accounted for over 80% of the total carbon content. The acidic hydrogen atoms existing in the different bamboo macromolecules mainly determined the electron-accepting component (γ_S^+) of bamboo scrimbers. Among them, carboxylic acids in hemicelluloses and phenolic functions in phenolic resin were more important compared to hydroxyl groups of polysaccharides, which represent lower acidity. Phenolic resin caused the increase in C_1 components, as well as the reduction of the C_2 and C_3 components. Therefore, the component γ_S^+ got increased when more phenolic resin was used in bamboo scrimbers.

In addition, the oxygen-to-carbon (O/C) atomic ratios were used to detect the effect of resin content on the surface wettability of bamboo scrimbers. As found in Figure 5, the O/C ratios of all bamboo scrimbers were in the range of 0.37 to 0.26. The O/C ratio of raw bamboo is 0.36–0.44 [37] and the cured phenolic resin is approximately 0.21 [43]. Therefore, the reduction in the O/C ratios of bamboo scrimbers compared to raw bamboo was ascribed to the addition of phenolic resin. Furthermore, the ratios decreased from 0.37 to 0.26 as the resin content increased from 9–15%, indicating that the O/C ratios were inversely proportional to the resin content. Matuana et al. [44] reported that the O/C ratios had a significant influence on surface wettability. Therefore, phenolic resin weakened the surface wettability of bamboo scrimbers by reducing the oxygen-containing groups. The decrease in the oxygen-containing groups likely caused a low electron-donating component (γ_S^-). The affinity of bamboo for water was considerably reduced as a consequence of phenolic resin. This was because phenolic resin acted as a barrier to hinder the formation of hydrogen bonds with water molecules by the electron pairs presenting on the oxygen atom of the hydroxyl groups [45]. As a result, the electron-donating component was strongly modified by phenolic resin. The high values were strongly correlated with the hydrophilic character of the surface that was associated with small contact angles, while the low values were correlated with hydrophobic character, leading to large contact angles.

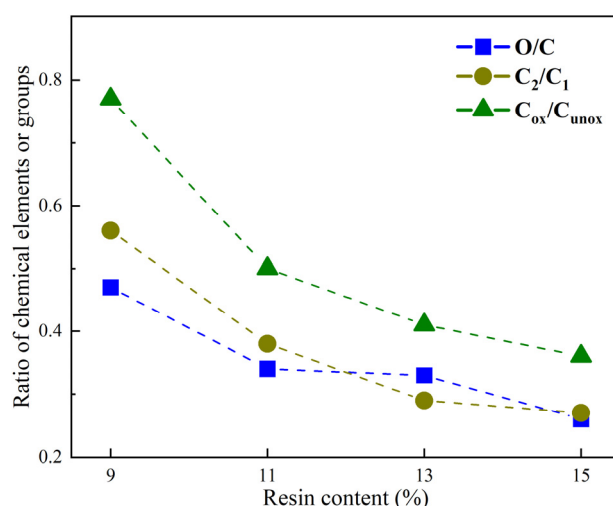


Figure 5. The ratios of O/C, C_2/C_1 and C_{ox}/C_{unox} on the scrimber surfaces.

The ratios of C_2/C_1 and C_{ox}/C_{unox} were also used to investigate the surface chemical composition. The C_2/C_1 ratio of raw bamboo was approximately 1.47 [37], and the cured phenolic resin was 0.11–0.25 [46]; the C_2/C_1 ratios (i.e., 0.6–0.2) of bamboo scrimbers were between them. Moreover, the addition of more phenolic resin led to a lower C_2/C_1 ratio due to fewer oxygen-containing groups on the scrimber surface. As seen in Figure 5, the C_{ox}/C_{unox} ratio showed the same trend as the C_2/C_1 ratio. The results suggested

that the oxygen-free composition had an increasing contribution to the scrimber surface. Consequently, the increase in non-polar components on the scrimber surface was found as the resin content increased.

3.5. FT-IR Analysis

Differences in the FT-IR spectra of bamboo scrimbers were investigated to further understand the change in chemical composition. The spectra in the range of 4000 to 600 cm^{-1} are shown in Figure 6. All bamboo scrimbers had a similar feature. The broad peak at 3327 cm^{-1} was attributed to the stretching vibration of O-H groups in cellulose and hemicellulose. The absorption peak at 2887 cm^{-1} was related to the stretching vibration of C-H groups. The peak at 1734 cm^{-1} was assigned to the stretching vibration of the non-conjugated carbonyl group (-COOH) in hemicellulose. The peak at 1465 cm^{-1} was due to the bending vibration of CH_2 groups in cellulose. The bands at 1239 and 1055 cm^{-1} corresponded to the stretching vibrations of the C-O groups in lignin and hemicellulose.

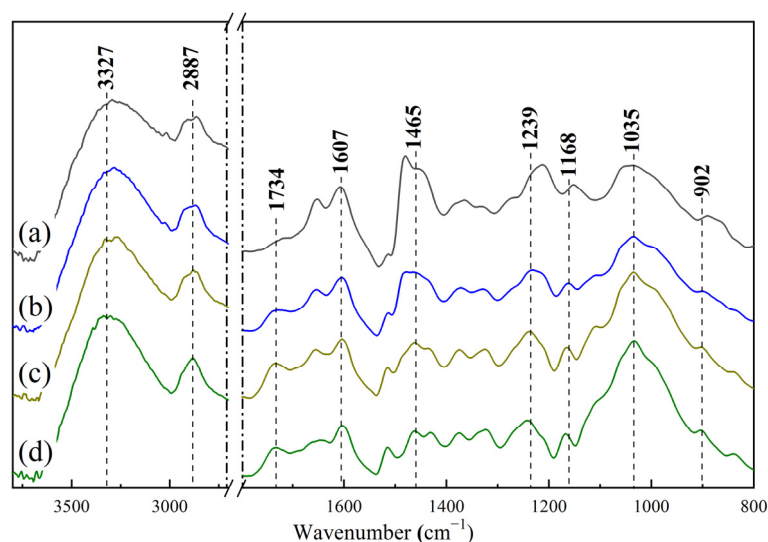


Figure 6. FT-IR spectra of bamboo scrimbers with different resin contents: (a) 9%, (b) 11%, (c) 13% and (d) 15%.

To compare the changes in surface chemical composition between the four bamboo scrimbers, the peak intensity was normalized based on the intensity of the peak at 1608 cm^{-1} because the C=C groups on aromatic skeletal groups were stable in bamboo [47]. The relative intensity of the representative peaks is presented in Figure 7. The oxygen-containing groups (i.e., -OH, C=O and C-O groups) decreased in intensity, but the oxygen-free groups (i.e., C-H and - CH_2 groups) increased when more resin was used in the scrimbers. The phenolic resin had fewer oxygen-containing groups than raw bamboo, and its use gave rise to a low content of oxygen-containing groups on the surface of the scrimbers. The -OH and C=O (-COOH) groups are hydrophilic [48], and their reduction contributed to the decrease in the polar free energy components. As a consequence, bamboo scrimbers had less surface wettability after the addition of more phenolic resin.

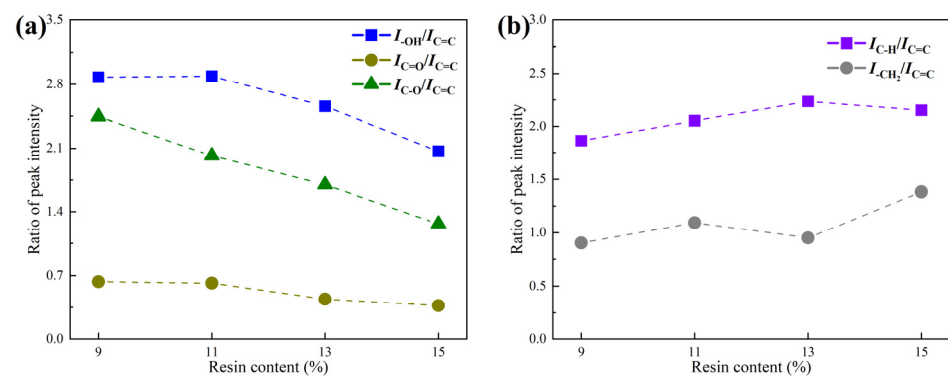


Figure 7. The ratios of representative peaks to C=C peak in intensity: (a) $I_{OH}/I_{C=C}$, $I_{C=O}/I_{C=C}$ and $I_{C-O}/I_{C=C}$; (b) $I_{C-H}/I_{C=C}$ and $I_{CH_2}/I_{C=C}$.

3.6. Coating Adhesion

Two kinds of commercial coatings were used to preliminarily study the coating adhesion of the scrimbers. Figures 8 and 9 presented the tested morphology of the waterborne and oil-based coatings on bamboo scrimbers, respectively.



Figure 8. WBV-coated surfaces of bamboo scrimbers with different resin contents: (a) 9%, (b) 11%, (c) 13% and (d) 15%.

There were obvious white vestiges on the scrimber surface, as shown in Figure 8. The vestiges were composed of a coating film stripped by the testing knife. The stripped film exhibited a serrated distribution along the scratching line, suggesting that there was good adhesion between the scrimbers and waterborne coatings. However, the scrimbers with high resin content had more obvious vestiges, indicating that the resin content affected the adhesion of waterborne coatings. Because the scrimber surface was hydrophilic, the waterborne coatings can easily wet the surface and thus a firm bonding interface was formed between the coating film and the scrimber surface. However, the water wettability had a decreasing trend when more resin was added in bamboo scrimbers. The low wettability affected the adhesion of the scrimber surface, leading to many vestiges forming on the surface. However, the stripped film did not peel off from the scrimber surface. According to the standard ISO 2409–2013, the adhesion level for all bamboo scrimbers should be 2, implying that the scrimbers had a good coating property on items of waterborne coatings.

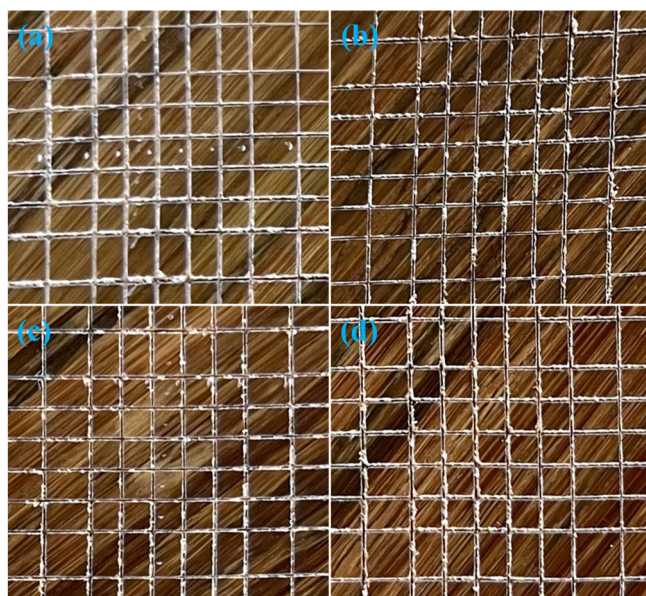


Figure 9. OBV-coated surfaces of bamboo scrimbers with different resin content: (a) 9%, (b) 11%, (c) 13% and (d) 15%.

Meanwhile, the scrimbers had good adhesion to the oil-based coatings. Figure 9 shows the morphology of the tested coating film on the scrimber surface. There were apparent ridges on the surface of the scrimber with a resin content of 9%, but just part of the coating film shed. This suggested that the scrimber had good adhesion to the oil-based coatings. However, the adhesion decreased as the resin content increased. As presented in Figure 9b, many ridges peeled off from the surface and obvious gaps appeared, suggesting a decreasing adhesion. Moreover, the adhesion became lower when the resin content got higher. Therefore, the resin content had a negative influence on the coating adhesion. This was due to the low surface free energy. However, the gap edges remained almost intact. As the same with the waterborne coatings, the oil-based coatings on the scrimbers had an adhesion level of 2 according to ISO 2409–2013.

4. Conclusions

In this study, the surface wettability of bamboo scrimbers with different resin contents was evaluated via the comprehensive analysis of surface roughness, surface contact angles and chemical composition. The results showed that all bamboo scrimbers had a similar profile with low roughness and that the roughness was not relevant to the resin content. The scrimber surfaces were hydrophilic but the addition of more phenolic resin led to a decrease in hydrophilicity. The total free energy increased when more phenolic resin was used in bamboo scrimbers. Meanwhile, the electron-accepting component became higher, but the electron-donating component was the opposite. The changes were attributed to the decrease in the hydrophilic groups (e.g., -OH and -COOH groups) and the increase in the oxygen-free groups (e.g., C-H and -CH₂ groups). The coating adhesion of the scrimbers was reduced by the increase in resin content, but the adhesion level still reached 2. In short, the resin content negatively affected the surface wettability of bamboo scrimbers, which should be taken seriously into account during the coating process. This will provide the surface coating of bamboo scrimbers with basic information about surface wettability to achieve good coating durability.

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Conflicts of Interest: The authors declare no conflict of interest.

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