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Preparation of Resin-Coated Waterborne Coating Microcapsules and Its Effect on the Properties of Waterborne Coating for Wood Surfaces

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Abstract: In this paper, the related experiments were carried out on microcapsules, with the aim of making the prepolymer react with the core emulsion by in situ polymerization using urea–formaldehyde resin as the wall material and waterborne acrylic wood coating as the core material. The prepared microcapsules were added to the waterborne acrylic wood coating and brushed on wood boards. Then, the gloss, hardness, adhesion, impact resistance and color difference were compared with paint surfaces without microcapsules. When the ratio of the microcapsule core-to-wall material was different from the increase in microcapsule content, the gloss of the coating decreased continuously; the decreasing range was basically the same, and the gloss values of the three core-wall ratio microcapsules were rather similar. With the increase in microcapsule content, the impact resistance of the coating first increased and then decreased. With the increase in microcapsule content, the color difference of the coating also increased continuously. The color difference of the coating with a microcapsule core-wall ratio of 0.67 changed the least, and the coating performance was good. When the core-wall ratio of the microcapsules was 0.67, and the proportion of microcapsules in the paint was 7.0%, the comprehensive properties of this coating were good. This research is of great significance to the future protection and development of wood.

Keywords: microcapsules; in situ polymerization; coating performance

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1. Introduction

Microcapsules, in a broad sense, are spherical vesicles with certain permeability, which are common under an optical microscope [1–3]. In the narrow sense, it is a kind of closed, tiny container covered by a polymer wall shell, and in a popular sense, it can be called a package [4]. The contents sealed in the containers are rich and varied, which can be solid, liquid, or even gas [5]. The outer-coating material used to coat microcapsules is usually called the capsule wall or wall material, and the inner-coating material is called the capsule core or core material [6,7]. There are also great differences in the particle sizes of common microcapsules, some of which are measured in millimeters and some of which are measured in microns [8–10]. Generally speaking, the diameter of most microcapsules with good morphology and protection effect is 1–500 μm [11], and the wall thickness is 0.5–150 μm. With the development of microcapsule technology, besides the known millimeter and micron levels in the market, there are already nano-level microcapsules. At present, the ultra-microcapsules with the smallest diameters are less than 1 μm. Microcapsule particles can be expanded to 0.25–1000 μm in some examples [12]. As for the membrane wall, the thickness is 1–30 μm. When the particle size of microcapsules is less than 5 μm, they are not easy to collect because of Brownian motion. When the particle size is larger than 30 μm, the surface friction coefficient will suddenly drop and lose its microencapsulation effect [13].

Therefore, controlling the core-wall ratio of microcapsules plays an important role in the final morphology and later coating effect of wood [14–19].

Microcapsule technology is a booming and interdependent technology; thus, it has also been applied to many aspects. In this process, the use of wood materials has been brought into full play and has played a positive role [20]. Microcapsule technology has the special advantage of controlled release and effective hiding, which provides a new platform for the development of functional wood materials [21,22]. Microencapsulation divides units with electrical, magnetic, optical, acoustic, thermodynamic, mechanical, chemical, and biomedical functions into stable small particles [23,24], which greatly increases the specific area of functional units and improves their functional effects [25]. According to the requirements of products with unique or mixed functional characteristics [26], improving the compatibility of fixed functional units, importing these small functional units into wood materials or concentrating them on their surfaces, and developing multifunctional wood materials can greatly reduce the consumption of functional units and prepare durable and functional wood materials [27–30].

In this paper, urea–formaldehyde resin was used as the wall material, and the waterborne acrylic wood coating as the core material. The in situ polymerization was used to make the prepolymer react with the core material emulsion, and the mixture was dried to make microcapsules. This paper explored whether the waterborne acrylic wood coating with microcapsules can effectively improve the gloss, mechanical properties, and color properties of wood surfaces, make its comprehensive performance optimal, and extend the service life of the wood.

2. Materials and Methods

2.1. Experimental Materials

Urea, formaldehyde aqueous solution (mass concentration 37%), and triethanolamine were purchased from Nanjing Chemical Reagent Co., Ltd. (Nanjing, China). Sodium dodecyl benzene sulfonate was purchased from Tianjin Beichen Fangzheng Reagent Factory (Tianjin, China). Citric acid was purchased from Tianjin Beilian Fine Chemicals Development Co., Ltd. (Tianjin, China). Waterborne acrylic wood coating was purchased from Nanjing Chemical Reagent Co., Ltd. (Nanjing, China). The basswood boards were provided by Yihua Life Technology Co., Ltd. (Shantou, China) with a specification of 50 mm × 50 mm × 10 mm.

2.2. Microcapsule Preparation

Using urea–formaldehyde resin as the wall material and waterborne acrylic wood coating as the core material, the prepolymer was reacted with the core emulsion using in situ polymerization; then, the mixture was dried and, finally, made into microcapsules (Table 1). The wall material was a urea–formaldehyde prepolymer obtained by reacting urea and formaldehyde; the core material was waterborne acrylic wood coating reacted with sodium dodecyl benzene sulphonate solution to obtain a stable emulsion.

Table 1. Microcapsule raw material ratio table.

Urea (g)	37% Formaldehyde Aqueous Solution (g)	Urea-Formaldehyde Resin (g)	Waterborne Acrylic Wood Coating (g)	Sodium Dodecyl Benzene Sulfonate (g)	Water (mL)	Core-Wall Ratio
20.00	27.00	30.00	12.00	0.92	92.30	0.40
20.00	27.00	30.00	20.00	1.56	154.44	0.67
20.00	27.00	30.00	25.00	1.95	193.05	0.83

2.2.1. Wall Material Preparation

A total of 20 g of urea and 27 g of formaldehyde aqueous solution were weighed, mixed at room temperature, and stirred with a glass rod until completely dissolved. The pH of the resulting solution was about 5. A magnetic stirrer was then added to the mixture, which was sealed with cling film and placed in a thermostatic stirrer with a reaction temperature

of 30 °C and a speed of 150 r/min for 1 h. The pH was then adjusted to about 9.0 by adding triethanolamine solution. The temperature of the mixed solution was then raised to 70 °C and stirred for 90 min to obtain a slightly viscous, clear, and clarified liquid, which was the wall solution.

2.2.2. Core Material Preparation

Taking the preparation process of the microcapsule core material with a core-to-wall ratio of 0.40 as an example: 0.92 g of sodium dodecylbenzene sulfonate powder was put into 92.30 mL of deionized water, then stirred with a glass rod until it was completely dissolved. The aqueous solution of sodium dodecylbenzene sulfonate with a concentration of 1%, which was used as the core material emulsifier, was obtained and added to 12 g of waterborne acrylic wood coating. The obtained mixture was stirred at 300 r/min for 25 min in a constant temperature water bath at 60 °C to obtain the core emulsion. The preparation of the microencapsulated cores with core-to-wall material ratios of 0.67 and 0.83 followed the same process used in the preparation of the microencapsulated cores with a 0.40 ratio, except that the quantities of sodium dodecyl benzene sulfonate powder and waterborne acrylic wood coatings were different, as seen in Table 1.

2.2.3. Microencapsulation

The wall urea–formaldehyde resin prepolymer was slowly dropped into the core emulsion, and the mixture was stirred in a constant temperature water bath at 30 °C for 1 h at 300 r/min. The citric acid was then added to adjust the pH of the mixture to 2.5–3.0 to obtain the white microcapsule emulsion, which was left to stand for about a week. After one week, the product was filtered and dried in an oven at 60 °C for 12 h; the resulting white powder was the urea–formaldehyde resin-coated waterborne acrylic coating microcapsules.

2.3. Coating Preparation

The prepared microcapsules were added into waterborne acrylic wood coating with mass fractions of 1.0%, 4.0%, 7.0%, 10.0%, 13.0%, 16.0% and 20.0%, respectively, then stirred and mixed evenly. The mixtures were, respectively, coated on basswood boards, and after standing and leveling at room temperature for 20 min, the coated basswood boards were put into a drying oven at 40 °C for 30 min and cured until the quality did not change. After drying, the coating thickness was about 60 μm.

2.4. Testing and Characterization

The surface morphology of the coating was observed using a scanning electron microscope (SEM, FEI Company, Hillsboro, OR, USA). The chemical composition of the microcapsules was analyzed by the VERTEX 80v Fourier Infrared spectrometer (German Bruck Co., Ltd., Karlsruhe, Germany). The test range was 4000–500 cm^{-1}, the sample scanning specimen was 16 s, and the resolution was 4 cm^{-1}. The self-made microcapsules were mixed with KBr, ground evenly, pressed into transparent sheets, and then detected using the infrared spectrometer. The gloss of the coating was tested by the HG268 glossmeter (Shenzhen Sanenshi Technology Co., Ltd., Shenzhen, China.), which was designed and manufactured according to ISO2813 and GB/T 9754-2007 [31]. The hardness and adhesion of the coating were tested using a QFH-HG600 six-blade cutting tool (designed and manufactured according to ISO2409-1992 and GB/T 6739-2006 [32]), 3M brand 600-1PK transparent pressure-sensitive adhesive tape (18 mm wide), a soft brush and the cross-marking method. A QCJ-50 paint film impactor tester (Shanghai Le'ao Test Instrument Co., Ltd., Shanghai, China), which was designed according to the GB1732-1993 [33] standard, was used to test the impact resistance of the paint film. A SEGT-J portable colorimeter (Zhuhai Tianchuang Instrument Co., Ltd., Zhuhai, China) was used to measure the color value of the paint film and calculate the color difference. Four samples were prepared for each measurement. The experimental results were verified by statistics. The measurement error was within 5%.

3. Results and Discussion

3.1. Microperformance Analysis of Microcapsules

Figure 1 shows the SEM images of the prepared microcapsules with a core-wall ratio of 0.40, 0.67, and 0.83. The surface of the powder taken out of the oven looked fine, and there was no obvious agglomeration or foreign matter. From the scanning electron microscope, it can be seen that the sample in Figure 1A has obvious spherical particles. The microcapsules with a core-wall ratio of 0.67 in Figure 1B can be seen to be obviously spherical and basically without damage. The sample in Figure 1C did not form spheres and showed irregular shapes. According to the above analysis, the preparation of the microcapsules with a core-wall ratio of 0.83 was not successful, and only a few spherical microcapsules were obtained.

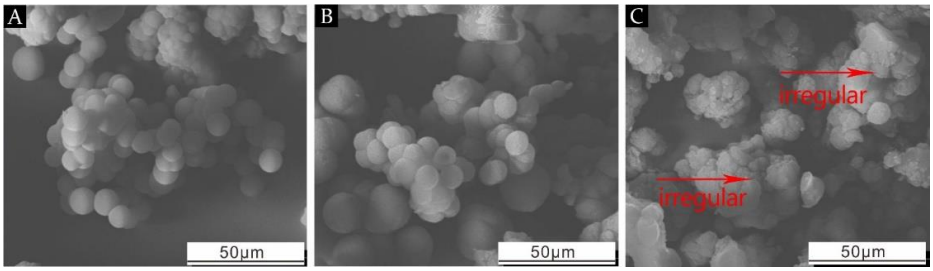

Figure 1. SEM (scanning electron microscope) images of microcapsules with three core-wall ratios (**A**) microcapsules with core-wall ratio of 0.40; (**B**) microcapsules with core-wall ratio of 0.67; (**C**) microcapsules with core-wall ratio of 0.83.

According to the infrared spectrum analysis of microcapsules in Figure 2, the absorption peak of N–H at 3355 cm^{-1} belongs to the characteristic functional group of urea–formaldehyde resin. The special absorption peak at about 1550 cm^{-1} is the characteristic absorption of C–N. The peak at 1644 cm^{-1} represents the stretching vibration of C=O in urea–formaldehyde resin, which confirms that the corresponding urea–formaldehyde resin wall material was produced in the prepared microcapsules [34]. The peaks at 2958 cm^{-1} and 2868 cm^{-1} are the characteristic absorption peaks of C–H, and the peak at 1720 cm^{-1} represents the characteristic peak of C=O in waterborne acrylic acid, which proves the existence of waterborne acrylic resin in the microcapsules [35]. The waterborne acrylic wood coating was in a liquid state, and the sample was the dry microcapsule particles; thus, it can be proved that the microcapsules of the urea-formaldehyde-encapsulated waterborne acrylic wood coating were successfully prepared.

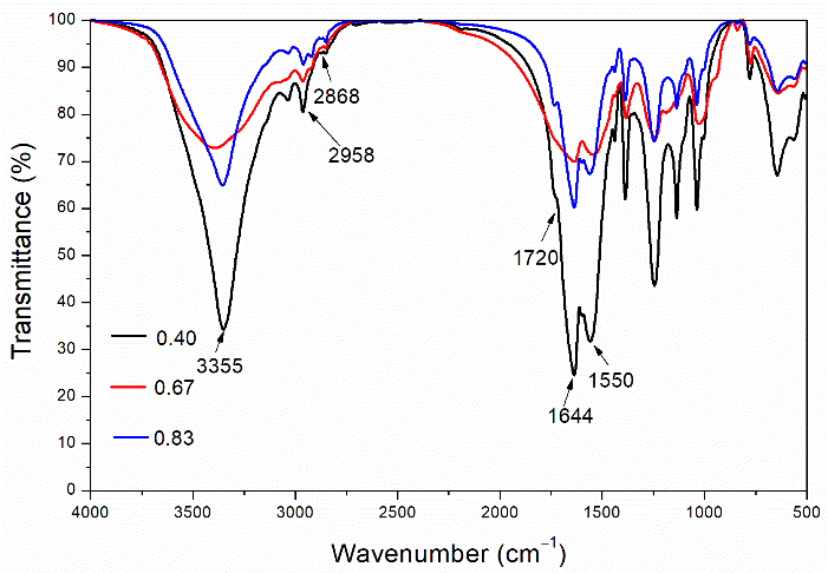

Figure 2. Infrared spectrum of the microcapsules with different core-wall ratios.

3.2. Gloss Analysis of Coating

It can be seen from Tables 2–4 that the gloss of the coating changed with the different content of the microcapsules in the same core-wall ratio when the light incident angle was the same, and the gloss of the coating basically showed a downward trend. When the core-wall ratio was 0.40, and the angle was 20 degrees, the proportion of microcapsules in the topcoat increased, and the gloss of the coating changed from 8.3 to 0.9. When the ratio of core-to-wall material was 0.67, and the angle was 20 degrees, the proportion of microcapsules in the topcoat increased, and the gloss of the coating changed from 8.3 to 1.7. When the ratio of the core-to-wall material was 0.83, and the angle was 20 degrees, the proportion of microcapsules in the topcoat increased, and the gloss of the coating changed from 8.3 to 0.9. Therefore, under the condition of a constant core-wall ratio and the same angle of ingestion, as the content of microcapsules increased, a larger proportion of microcapsules was added to the topcoat; the greater the particles on its surface, the rougher it is, resulting in increased reflection and lower gloss of the coating. The gloss values of the three core-wall ratio microcapsules were rather similar.

Table 2. Gloss performance table with core ratio of 0.40.

Content Ratio of Microcapsules (%)	Gloss at 20 Degrees (GU)	Gloss at 60 Degrees (GU)	Gloss at 85 Degrees (GU)
0	8.3	11.1	11.5
1.0	2.3	10.0	10.3
4.0	1.9	9.5	10.1
7.0	1.7	5.8	7.3
10.0	1.4	2.5	2.9
13.0	1.3	2.2	2.7
16.0	1.1	1.5	1.8
20.0	0.9	1.1	1.3

Table 3. Gloss performance table with core ratio of 0.67.

Content Ratio of Microcapsules (%)	Gloss at 20 Degrees (GU)	Gloss at 60 Degrees (GU)	Gloss at 85 Degrees (GU)
0	8.3	11.1	11.5
1.0	6.5	5.8	8.9
4.0	4.2	5.3	6.3
7.0	3.1	3.9	1.1
10.0	2.6	2.9	0.7
13.0	2.1	2.3	0.5
16.0	1.9	1.7	0.2
20.0	1.7	1.6	0.1

3.3. Hardness Analysis of Coating

The value 6H was the hardest for the hardness, which represented the highest hardness. The hardness decreased from 6H to 6B. It can be seen from Table 5 that when the ratio of core-to-wall material was 0.40, and the content of microcapsules increased from 0% to 7.0%, the hardness of the coating was HB, which was unchanged. When the content continued to increase, from 7.0% to 20.0%, the coating hardness decreased from HB to B. When the ratio of core-to-wall material was 0.67, and the content of microcapsules increased from 0% to 7.0%, the hardness of the coating was HB, which was unchanged. When the content continued to increase, from 7.0% to 20.0%, the coating hardness decreased from HB to 2B. When the ratio of core-to-wall material was 0.83, and the content of microcapsules

increased from 0% to 4.0%, the hardness of the coating was HB, which was unchanged. When the content continued to increase, from 4.0% to 20.0%, the hardness of the coating decreased from HB to 3B. It can be concluded that when the core-wall ratio is the same, adding a small number of microcapsules does not affect the hardness of the coating. As microcapsule content increased, there were more microcapsules in the coating, and the hardness of the coating surface gradually decreased. When the core-wall ratio was 0.40 and 0.67, and the content of microcapsules in the coating was 0%–7.0%, the coating hardness was the best, reaching HB.

Table 4. Gloss performance table with core ratio of 0.83.

Content Ratio of Microcapsules (%)	Gloss at 20 Degrees (GU)	Gloss at 60 Degrees (GU)	Gloss at 85 Degrees (GU)
0	8.3	11.1	11.5
1.0	2.9	8.6	9.3
4.0	2.6	7.9	8.5
7.0	2.1	6.3	7.2
10.0	1.8	5.7	6.8
13.0	1.7	5.1	5.9
16.0	1.6	4.1	4.8
20.0	0.9	1.8	2.3

Table 5. Hardness test table.

Microcapsule Content (%)	Hardness for Core-Wall Ratio 0.40	Hardness for Core-Wall Ratio 0.67	Hardness for Core-Wall Ratio 0.83
0	HB	HB	HB
1.0	HB	HB	HB
4.0	HB	HB	HB
7.0	HB	HB	B
10.0	B	B	2B
13.0	B	B	2B
16.0	B	2B	3B
20.0	B	2B	3B

3.4. Adhesion Analysis of Coating

It can be seen from Table 6 that when the core-wall ratio was 0.40, the microcapsule content in the topcoat gradually increased from 1.0% to 20.0%, and the adhesion of the coating changed from grade 1 to grade 2. When the ratio of core-to-wall material was 0.67, the adhesion of the coating changed from grade 1 to grade 2. When the core-wall ratio was 0.83, the adhesion of the coating also changed from grade 1 to grade 3. Therefore, when the core-wall ratio is the same, the higher the content of microcapsules in the topcoat, the more the coating is damaged and the poorer the adhesion. When the core-wall ratio was 0.40, and the content of microcapsules in the coating was 1.0%–7.0%, the coating adhesion effect was the best.

3.5. Impact Analysis of Coating

It can be seen from Figure 3 that under the impact of the hammer, when the core-wall ratio was 0.40, and the microcapsule content in the topcoat increased from 0% to 13.0%, the impact resistance of the coating was enhanced, which resulted in the best impact resistance of 23 kg·cm. When the content continued to increase from 13.0% to 20.0%, the microcapsules in the coating agglomerated, and the impact resistance weakened. The microcapsules agglomerated seriously in the coating, and the mechanical chain force of the coating decreased; thus, the impact resistance decreased. When the core-wall ratio

was 0.67, and the microcapsule content in the coating increased from 1.0% to 16.0%, the impact resistance fluctuated between 14 kg·cm and 20 kg·cm. When the content increased from 16.0% to 20.0%, the impact resistance remained constant at 20 kg·cm, and it was the best state of impact resistance. When the ratio of core-to-wall material was 0.83, and the content of microcapsules in the coating increased from 1.0% to 7.0%, the impact resistance remained unchanged at 10 kg·cm. When the content increased from 7.0% to 10.0%, the impact resistance increased from 10 kg·cm to 20 kg·cm. When the content increased from 10.0% to 16.0%, the impact resistance decreased from 20 kg·cm to 15 kg·cm. When the content increased from 16.0% to 20.0%, the impact resistance remained at 15 kg·cm. The optimum impact resistance of this core-wall ratio was 20 kg·cm. Therefore, when the coating was tested for impact resistance, under the condition that the basswood was uniformly coated, a small number of microcapsules did not have an excessive impact on the impact performance due to the uniform particle size distribution during coating. As the number of microcapsules increased, the impact resistance was better in a certain range, but there was a certain relative critical value beyond which the impact resistance of the coating decreased. When the core-wall ratio was 0.40, and the microcapsule content was 13.0%, the impact resistance of the coating on the basswood reached 23 kg·cm.

Table 6. Adhesion test table.

Microcapsule Content (%)	Adhesion for Core-Wall Ratio 0.40 (grade)	Adhesion for Core-Wall Ratio 0.67 (grade)	Adhesion for Core-Wall Ratio 0.83 (grade)
0	1	1	1
1.0	1	1	1
4.0	1	2	1
7.0	1	2	1
10.0	2	2	2
13.0	2	2	2
16.0	2	3	2
20.0	2	3	3

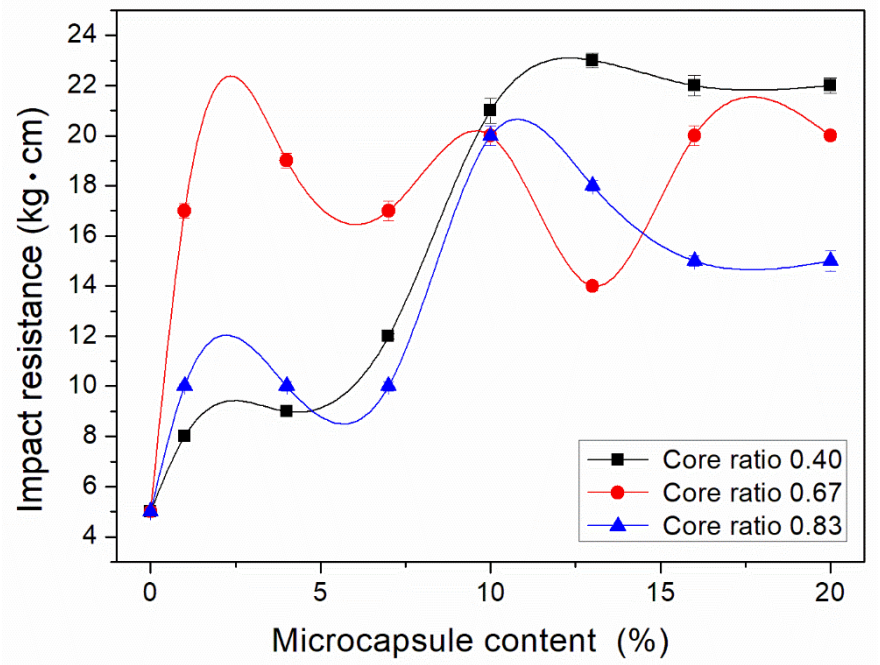

Figure 3. Impact resistance of the coating at the different core-wall ratios and different microcapsule content.

3.6. Color Difference Analysis of Coating

Where L is brightness, $\triangle L$ is the brightness difference of two different positions for the same coating. When the L value is large, it means that the coating color on the surface of the tested board is bright, and when the value is small, it means that the coating color on the surface of the tested board is dark [36,37]. The value a is the red-green hue, that is, the color-changing process from red to green. When the value is positive, the color is reddish, and when the value is negative, the color is greenish. The value b is the yellow-blue phase, that is, the color-changing process from yellow to blue. When the value is positive, the color is yellowish, and when the value is negative, the color is bluish. The value c represents color saturation. H stands for hue. $\triangle E$ stands for color difference. From Tables 7–9, it can be that when the core-wall ratio was 0.40, and the content increased from 1.0% to 4.0%, $\triangle E$ decreased from 3.8 to 3.7. When the content increased from 4.0% to 20.0%, $\triangle E$ increased continuously, from 3.7 to 28.4. If the color difference was too large, the color of the coating was more uneven, and the quality of the coating was worse. When the core ratio was 0.83, and the content increased from 1.0% to 10.0%, $\triangle E$ increased from 2.9 to 15.9. When the content increased from 10.0% to 20.0%, the data of $\triangle E$ decreased first and then increased. On the other hand, when the core-wall ratio was 0.67, the color difference continuously increased from 4.9 to 12.3, which indicates that the partial agglomeration of microcapsules appears during coating. Compared with the microcapsules with core-wall ratios of 0.40 and 0.83, the coating prepared by the microcapsules with a core-wall ratio of 0.67 had a relatively small color difference change; even with the high content of microcapsules (7.0%–20.0%), the color difference $\triangle E$ was smaller, and the coating quality was better.

Table 7. Color values of the coatings with core-wall ratio of 0.40.

Microcapsule Content (%)	*L*	*a*	*b*	*c*	*H*	$\triangle L$	$\triangle a$	$\triangle b$	$\triangle E$
0	74.9	12.6	32.2	34.6	68.5	0	0.1	−0.8	0.8
1.0	8.5	1.1	3.9	4.1	73.5	1.4	−1.6	3.2	3.8
4.0	27.4	2.4	11.0	11.3	77.4	1.7	−0.8	−3.2	3.7
7.0	27.5	7.5	7.0	10.3	42.7	3.3	−0.2	3.9	5.2
10.0	29.5	3.3	11.4	11.9	73.9	3.1	−3.5	−2.9	5.3
13.0	31.8	4.9	15.2	16.0	72.2	5.3	−0.8	−8.0	9.7
16.0	64.9	6.7	21.6	22.5	72.7	−8.1	−8.2	−10.7	27.9
20.0	27.1	15.2	17.2	23.0	75.0	−4.1	−13.5	24.6	28.4

Table 8. Color values of the coatings with core-wall ratio of 0.67.

Microcapsule Content (%)	*L*	*a*	*b*	*c*	*H*	$\triangle L$	$\triangle a$	$\triangle b$	$\triangle E$
0	74.9	12.6	32.2	34.6	68.5	0	0.1	−0.8	0.8
1.0	27.2	2.3	9.1	9.4	75.8	3.1	2.1	3.1	4.9
4.0	30.3	2.9	7.2	7.7	67.7	5.3	0	4.0	6.6
7.0	26.8	4.6	8.2	9.5	60.6	5.0	−0.8	−6.4	8.2
10.0	27.1	2.9	7.5	8.0	68.4	−7.6	−3.3	0.1	8.3
13.0	27.2	2.3	9.1	9.4	75.8	6.3	−7.1	−1.2	9.5
16.0	17.8	−0.8	8.4	8.5	95.5	9.5	1.9	−0.4	9.7
20.0	26.2	2.3	9.9	10.2	76.8	−1.7	3.8	−7.3	12.3

3.7. Microperformance Analysis of Coating

On the basis of the above performance tests, the coating with a core-wall ratio of 0.67 was better. Two coated basswood samples with microcapsule contents of 7.0% and 16.0%

were selected for the scanning electron microscope (Figure 4). It can be found that with the increase in microcapsule content, the microcapsules in the coating are unfavorable to dispersion. The microcapsule particles in the coating are evenly distributed at a content of 7.0%. When the content of microcapsules was 16.0%, the coating was uneven and showed agglomeration, which indicates that the surface is rougher.

Table 9. Color values of the coatings with core-wall ratio of 0.83.

Microcapsule Content (%)	*L*	*a*	*b*	*c*	*H*	△*L*	△*a*	△*b*	△*E*
0	74.9	12.6	32.2	34.6	68.5	0	0.1	−0.8	0.8
1.0	26.6	1.4	9.3	9.4	81.1	0.9	−0.8	−2.6	2.9
4.0	31.0	3.7	8.6	9.4	66.5	1.7	−1.8	−1.7	3.0
7.0	37.1	−0.7	7.4	7.4	95.9	−2.5	5.4	0	6.0
10.0	36.9	4.0	13.0	13.6	72.8	−5.4	0	−4.9	15.9
13.0	30.4	2.3	8.5	8.9	74.5	−5.3	2.5	−5.9	8.3
16.0	28.1	2.2	8.4	8.7	74.9	10.2	0.5	2.8	10.7
20.0	26.6	16.8	8.6	10.2	58.0	6.5	−1.4	−5.2	13.8

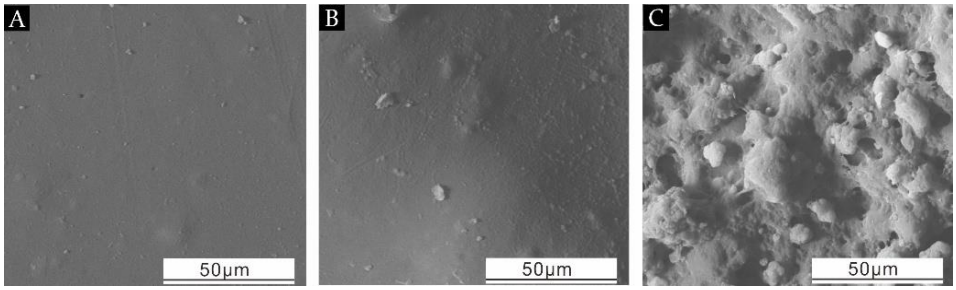

Figure 4. SEM images of coating with the microcapsule core-wall ratio of 0.67: (**A**) no microcapsules; (**B**) the microcapsule content is 7.0%; (**C**) the microcapsule content is 16.0%.

4. Conclusions

With the increase in microcapsule content, the hardness of the coating decreases. When the core-wall ratio is 0.40 and 0.67, and the content of microcapsules in the coating is 0%–7.0%, the surface hardness is the best, which can reach HB. With the increase in microcapsule content, the adhesion of the coating also decreases. When the microcapsule core-wall ratio is 0.40, and the content is 1.0%–7.0%, the coating adhesion is the best. When the core-wall ratio is 0.40, and the microcapsule content is 13.0%, the impact resistance of the coating can reach 23 kg·cm. When the ratio of microcapsule core-to-wall material is 0.67, and the content of microcapsules in the coating is 7.0%, the hardness was HB, the gloss at 60 degrees was 3.9 GU, the adhesion was grade 2, and the impact resistance was 17 kg·cm; therefore, at this ratio, the comprehensive properties of coatings are good. The next work will be on the chemical resistance of the coating, and the cohesion between the coating and the wood substrate will be considered from the wood microstructure.

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