

Research Article

The Potential of Transparent Wood Biocomposites for Sustainable Acoustics Panel Membrane

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Article Info	Abstract
Article History	Acoustic comfort is vital in indoor environments, and the demand for efficient sound-absorbing materials is increasing. While effective, traditional porous materials like rock wool and glass wool pose health risks due to the emission of fine fibers, leading to interest in safer alternatives, such as membrane-based panels. Transparent Wood (TW), a novel material created by removing lignin from wood, offers both sound-absorbing capabilities and environmental benefits. This study aims to evaluate the acoustic performance of TW-based membrane panels by investigating their sound absorption characteristics and the underlying mechanisms of absorption. Maple (<i>Acer laurinum</i>) and mahogany (<i>Swietenia macrophylla</i>) wood veneers were delignified with NaClO ₂ in an acetate buffer solution and H ₂ O ₂ , followed by polymer impregnation using epoxy resin. The sound absorption capabilities of TW were investigated through morphological analysis using Scanning Electron Microscopy (SEM) and acoustic performance testing via the impedance tube transfer function method. TW membrane panels have the potential to be sound-absorbing materials with absorption rates exceeding 20% at frequencies ranging from 400 to 3150 Hz. The highest absorption occurs at 630 Hz ($\alpha = 0.659$ for maple wood and 0.603 for mahogany wood) and at 2500 Hz ($\alpha = 0.533$ for maple wood and 0.548 for mahogany wood). The sound absorption mechanism of TW resembles that of a membrane absorber, in which the air cavity acts as an acoustic spring and the panel acts as the vibrating mass. By understanding the acoustic analysis in this study, it is hoped that TW-based membrane panels can be used as sustainable sound-absorbing materials.
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1. Introduction

Acoustic comfort is a crucial element in indoor environments, particularly in areas that require concentration, communication, or relaxation. As modern living and working spaces increasingly prioritize health and comfort, the demand for effective, safe, and sustainable sound-absorbing materials has significantly grown [1, 2]. Conventional materials used for acoustic treatment generally fall into three broad

categories: porous absorbers, membrane-based panels, and microperforated systems [3]. Among these, porous materials such as rock wool, glass wool, polyurethane, and polyester fibers have long been favored for their ability to absorb sound energy and control reverberation in enclosed spaces [4, 5]. However, despite their effectiveness, the fiber-based nature of these materials poses health concerns. They can emit fine particulate matter, which, if inhaled over time, can lead to respiratory irritation or more serious conditions [5].

In response to the drawbacks of porous absorbers, membrane-based systems have gained attention as safer alternatives for sound-absorbing applications [6]. Membrane panels are solid and non-fibrous, minimizing the risk of airborne particle emission. The closed-surface structure also facilitates easy cleaning and enhances resistance to microbial contamination, making these absorbers highly suitable for hygiene-sensitive environments such as healthcare facilities, laboratories, and educational institutions [7]. However, despite their hygienic and functional advantages, most membrane absorbers rely on synthetic, non-renewable materials, raising sustainability concerns [8].

Transparent wood (TW) has emerged as a promising bio-based alternative. It is fabricated by removing lignin from natural wood to achieve translucency, followed by polymer impregnation to restore mechanical strength and structural integrity [9, 10]. Beyond its optical and mechanical benefits, TW exhibits potential as an acoustic membrane material. It is an anisotropic wood framework reinforced with polymer, which retains sufficient stiffness and elasticity to vibrate when backed by an air cavity, enabling sound absorption through resonance [11]. In this configuration, the panel functions as the vibrating mass, and the air gap acts as the acoustic spring, forming a spring–mass system that governs absorption behavior, particularly across the low to mid-frequency range [12, 13].

Moreover, TW aligns with the growing architectural demands for materials that support acoustic comfort and visual openness. As modern buildings increasingly emphasize illuminated, health-conscious spaces, materials capable of transmitting natural light while attenuating sound have become highly valuable [14, 15]. This condition highlights the potential of TW for multifunctional interior applications, especially in environments such as offices, hospitals, and schools that require visual transparency and effective acoustic performance.

Our previous work primarily focused on the fabrication and thermal-optical evaluation of TW made from locally available Indonesian hardwoods, yielding excellent results in terms of light transmission and mechanical durability [16]. However, the acoustic behaviour of transparent wood, particularly its effectiveness as a membrane absorber, remains underexplored. Therefore, this study aims to fill that gap by analyzing the acoustic performance of TW fabricated from maple and mahogany. It evaluates their sound absorption characteristics in conjunction with their known thermal and optical properties, thereby supporting TW's potential role in sustainable, multifunctional architectural applications.

2. Literature Review

2.1. Development of Transparent Wood as a Functional Material

Transparent Wood (TW) is a biocomposite material that has gained significant attention due to its multifunctionality, combining the structural benefits of wood with transparency, thermal insulation, and mechanical strength. The fabrication process of TW generally involves two main steps. The first is delignification, a chemical treatment that removes lignin, which is responsible for the wood's natural color and opacity. This step is followed by polymer impregnation, which restores mechanical strength and matches the refractive index of the wood structure to achieve optical clarity [17].

Building on the development of TW and its functional characteristics, Hu, et al. [18] conducted a comprehensive review of TW's potential, with a particular emphasis on its suitability for architectural applications, such as smart windows and daylighting panels. The review highlighted TW's ability to reduce energy consumption through passive cooling and underscored the need for further investigation into its acoustic properties. Motivated by these insights, our previous work focused on fabricating TW from locally available Indonesian wood species. It demonstrated high light transmittance (81.43% for maple and 86.03% for mahogany), strong mechanical performance, and significant passive cooling effects due to its low thermal conductivity [16]. Despite these advantages, the acoustic behavior of TW remains largely unexplored in existing studies, particularly in terms of its potential as a membrane-type absorber.

2.2. Influence of Microstructure on Acoustic Performance

The material's microstructure plays a crucial role in determining its acoustic performance. Zhao, et al. [19] investigated delignified wood with intentionally preserved porosity and reported improved sound absorption at low to mid frequencies. Using the impedance tube method, the study confirmed that higher porosity enables more sound energy to be trapped and dissipated within the material structure [19]. In contrast, TW typically exhibits low porosity due to epoxy resin infusion, which enhances structural rigidity but limits conventional absorption through pores. These internal structural differences are closely linked to the dominant sound absorption mechanisms. In porous absorbers, such as fibrous or foam-based materials, sound energy is primarily dissipated through viscous and thermal losses as air particles are forced through narrow channels [20, 21]. This frictional interaction converts acoustic energy into heat, making porous absorbers particularly effective at mid-to-high frequencies.

On the other hand, membrane absorbers operate through an entirely different mechanism. Thin, non-porous panels vibrate in response to incident sound, interacting with a backing air cavity to form a resonant system. Energy is dissipated through internal damping and acoustic impedance mismatch, with peak absorption typically occurring at the resonance frequency determined by surface mass and cavity depth [22, 23]. These two mechanisms form the theoretical foundation for designing hybrid or multifunctional acoustic panels, including materials with tailored microstructures such as TW.

2.3. Acoustic Principles of Membrane Absorbers

TW exhibits acoustic potential primarily through its behaviour as a membrane-type absorber. In this incident, sound waves induce panel vibrations, interacting with a backing air cavity to dissipate energy. This resonant mechanism is well established in acoustic theory, particularly in the works of Kinsler, et al. [24] and Cox and d'Antonio [25], who describe membrane absorbers as spring–mass systems governed by the interaction between the vibrating panel (mass) and the air cavity (spring). The resonance frequency can be estimated using a simplified formulation, presented in equation (1), assuming an air-filled cavity and a uniformly vibrating membrane [25].

$$f = \frac{60}{\sqrt{md}} \quad (1)$$

where:

- f is the resonance frequency in Hz,
- m is the surface mass density of the membrane in kg/m²,
- d is the air cavity depth in meters.

This empirical formula is derived from the more general acoustic impedance model for resonant systems, where the resonance condition occurs when the imaginary part of the surface impedance becomes zero [25]. The equation assumes the system behaves adiabatically and that the air cavity depth is much smaller than the acoustic wavelength.

2.4. Summary of Research Gaps and Study Objectives

Despite growing interest in TW, most studies have focused on its optical and thermal characteristics. Our previous study laid the groundwork by identifying maple and mahogany as optimal species for TW fabrication based on their mechanical and optical properties [16]. This study seeks to address that gap by evaluating the sound absorption performance of TW fabricated from maple and mahogany, particularly in membrane absorber configurations. It builds on morphological findings and theoretical resonance models to position TW as a viable acoustic panel, offering a combination of aesthetic, environmental, and acoustic functionality.

3. Materials and Methods

3.1. Materials

Rotary-cut mahogany and maple with a thickness of 0.6 mm were acquired from local wood veneer suppliers. In terms of material properties, mahogany exhibited a moisture content of $12.4\% \pm 0.3\%$, while maple showed a slightly lower value of $10.2\% \pm 0.3\%$. Mahogany had a measured density of 0.54 ± 0.005 g/cm³, whereas maple exhibited a higher density of 0.66 ± 0.006 g/cm³. The sodium chlorite (NaClO₂, 1 wt%), hydrogen peroxide (H₂O₂, 5 mol/L), and ethanol (C₂H₅OH) used in this study were of technical grade. The epoxy system consisted of epoxy resin A (bisphenol A-epichlorohydrin) and a

cycloaliphatic amine hardener (EPH 555).

3.2. Transparent Wood Fabrication

The fabrication of transparent wood started with the preparation of 0.6 mm-thick wood veneers, which were cut into 3 cm and 10 cm diameter circles for acoustic performance testing. The veneers were cleaned using an ultrasonic cleaner for 10 minutes to remove surface contaminants. Delignification was then carried out to render the wood translucent. A solution of 3.34 g sodium acetate trihydrate, 2.3 mL acetic acid, and 2.6 g sodium chlorite (1 wt%) in 250 mL of water was heated to 80 °C for 3 hours. The samples were subsequently immersed in 5 mol/L hydrogen peroxide at 90 °C for 1 hour until they turned white, followed by ethanol soaking for at least 24 hours to stabilize the structure.

Following delignification, the polymer impregnation process was performed by infusing the samples with epoxy resin A and hardener EPH 555 (3:1 ratio, $n = 1.53$) to match the refractive index of the wood matrix. The samples were treated in a vacuum chamber for 36 minutes using repeated cycles to ensure full resin penetration and air removal. In the final curing and cleaning step, the samples were clamped between wax-coated glass slides and left to cure for 24 hours. After curing, residual wax was removed using ethanol, completing the transparent wood fabrication process.

3.3. Laboratory Testing

3.3.1. Acoustic Performance Testing

The samples tested in this study were transparent wood panels designed to operate as membrane absorbers supported by an air gap. To simulate this configuration, a custom casing was fabricated using 3D printing with polylactic acid (PLA) material, which served as the structural enclosure for the system. The transparent wood panel was mounted on one side of the casing, while the back side consisted of a solid PLA wall, creating a fixed 2 cm air cavity between them. This setup was intended to replicate the behaviour of a membrane absorber, in which the transparent wood acts as the vibrating mass and the enclosed air cavity serves as the acoustic spring. Figure 1 illustrates the composite structure, comprising a transparent wood layer, an air gap, and a PLA casing.

Acoustic performance testing was conducted using the impedance tube transfer function method (ISO 10534-2) to determine the sound absorption coefficient (α) of each sample. The experiments utilized a PLACID Z-Series system, which consisted of a white noise source, two precision microphones, a signal conditioner, and the proprietary Sound Express software. Both transparent maple and mahogany samples were tested across three frequency bands, low (50–400 Hz), mid (400–1250 Hz), and high (1250–6300 Hz), using different tube sizes appropriate to each range. Six individual samples were tested for every wood type and frequency band to ensure repeatability. Microphones were calibrated with a 94 dB tone at 1 kHz and swapped between measurements to minimize phase-related errors. Test details are provided in Table 1.



Figure 1. Transparent Wood Air Gap Casing

Table 1. Acoustic testing sample details

No.	Sample Variations	Diameter	Number of Samples	Frequency Bands Tested
1	Transparent Maple Wood + Air Gap	3 cm	6	Low, Mid, High
2	Transparent Maple Wood + Air Gap	10 cm	6	Low, Mid, High
3	Transparent Mahogany Wood + Air Gap	3 cm	6	Low, Mid, High
4	Transparent Mahogany Wood + Air Gap	10 cm	6	Low, Mid, High

During testing, a broadband white noise signal was injected into the tube, and the microphones recorded the incident and reflected sound waves. The Sound Express software computed the transfer function between the two microphone signals and used this data to calculate the complex reflection coefficient (R). The absorption coefficient was then determined using the equation $\alpha = 1 - |R|^2$. The absorption data from the three frequency bands were combined to form a full-spectrum absorption profile for each sample, covering 50 Hz to 6300 Hz.

3.3.2. Morphological Evaluation

Morphological analysis of the transparent wood samples was conducted using an Electron Probe Microanalyzer (EPMA) integrated with a Scanning Electron Microscope (SEM). The SEM was utilized to capture high-resolution images at the microscale, providing detailed observations of the surface and internal structures of the samples, including the pore characteristics. Before SEM analysis, the samples were prepared by cutting them into rectangular shapes measuring 1 cm × 2 cm. To enhance electrical conductivity and prevent surface charging during imaging, the samples were coated with a thin layer of carbon using a Vacuum Evaporator. This carbon coating ensured clearer and more accurate image acquisition. SEM

imaging was performed at an operating voltage of between 10 and 15 kV, which is optimal for resolving fine structural details without causing sample damage. Proper sample preparation, conductive coating, and optimized SEM settings enabled an accurate morphological evaluation, critical to understanding the structural modifications resulting from the transparent wood fabrication process.

4. Result

4.1. Transparent Wood Fabrication

Figure 2 shows the finished TW panels, made from rotary-cut mahogany and maple, both of which exhibit substantial transparency. Each panel, with a final thickness of approximately 1 mm, successfully transformed from opaque to translucent, allowing the printed text beneath the surface to remain visible. Some haze remains due to residual microstructural irregularities; however, optical clarity was maintained across all samples.



Figure 2. Fabrication Wood Result (a) Maple (b) Mahogany

A total of 24 circular samples (12 from each wood species) were evaluated to assess acoustic performance. Each wood type was tested using two panel diameters (3 cm and 10 cm) across three frequency bands: low (50–400 Hz), mid (400–1250 Hz), and high (1250–6300 Hz). The absorption coefficient data from each range were interpolated using 1/3-octave band analysis to construct continuous full-spectrum absorption profiles from 50 to 6300 Hz. This approach provided a representative view of each material's acoustic response across the audible range.

4.2. Morphological Evaluation

Figure 3 shows the surface morphology of a transparent wood panel at 200 $\times$ magnification. The surface appears smooth, continuous, and free from visible pores or undulations. This level of surface uniformity indicates a dense, well-sealed structure, which is characteristic of membrane-like materials. The absence of roughness or open pores suggests minimal potential for surface scattering or frictional trapping of acoustic energy, supporting its suitability for membrane-based absorption behavior.

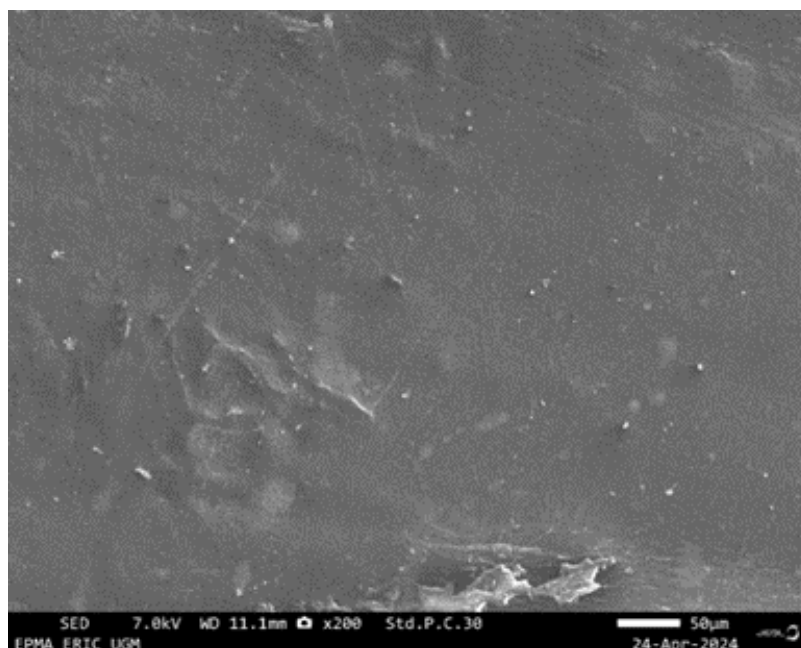


Figure 3. SEM test image of transparent wood at 200x magnification before being sliced

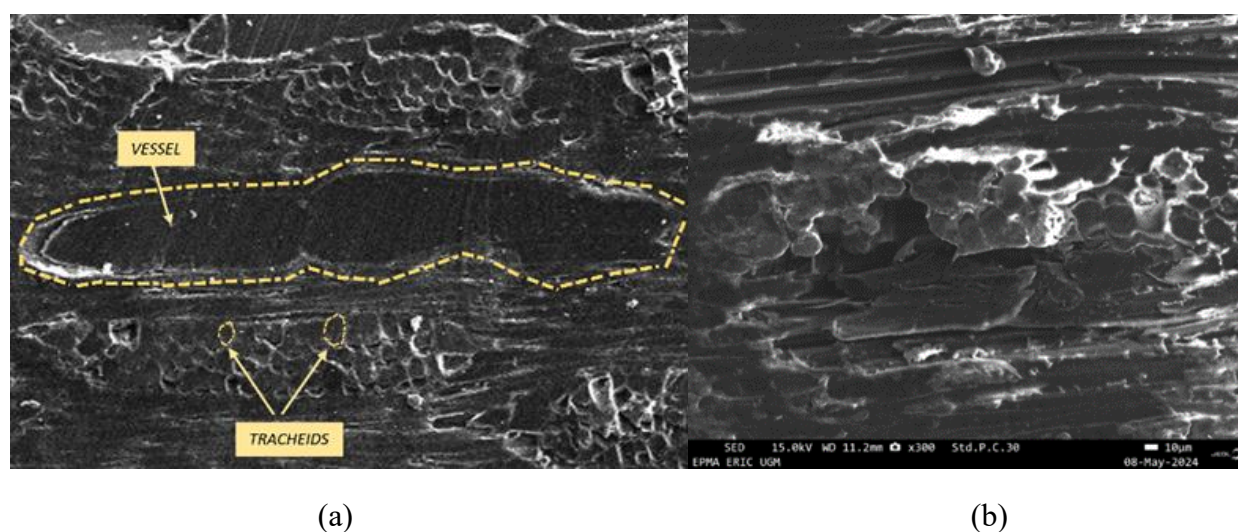


Figure 4. SEM test image: (a) Transparent wood after slicing at 50x magnification, (b) Transparent wood after slicing at 300x magnification

To complement the surface analysis, internal cross-sections were examined to gain a deeper understanding of the material's internal structure. Samples were sliced into 1×2 cm rectangles and imaged at $50\times$ and $300\times$ magnifications, as shown in Figures 4a and 4b, respectively. At $50\times$ magnification (Figure 4a), the cross-section reveals a homogeneous, fully filled network with no visible open-cell structures or air voids. Tracheids and vessels, typically observed in untreated wood, appear completely impregnated with epoxy, effectively blocking any continuous pore pathways. Figure 4b provides a higher-resolution image at $300\times$ magnification, confirming that the epoxy resin has thoroughly infiltrated the cell walls and lumens. No microcracks or interconnected porosity are visible, and the thickened appearance of the cell walls likely

results from resin uptake and polymer curing. These morphological observations indicate that the delignification and resin infusion process produced a structurally dense, closed-cell composite, devoid of the porous channels typically found in untreated wood.

4.3. Acoustic Absorption Performance

Figure 5 presents the averaged absorption coefficient data for TW panels fabricated from maple (composite A) and mahogany (composite B). Both panels exhibited clear resonance behavior, with two prominent absorption peaks appearing within the measured spectrum. The first and most pronounced peak occurred at 630 Hz, where composite A reached an absorption coefficient of 0.659, and composite B was slightly lower at 0.603. This strong mid-frequency absorption is particularly relevant for managing speech-related and ambient office noise [26].

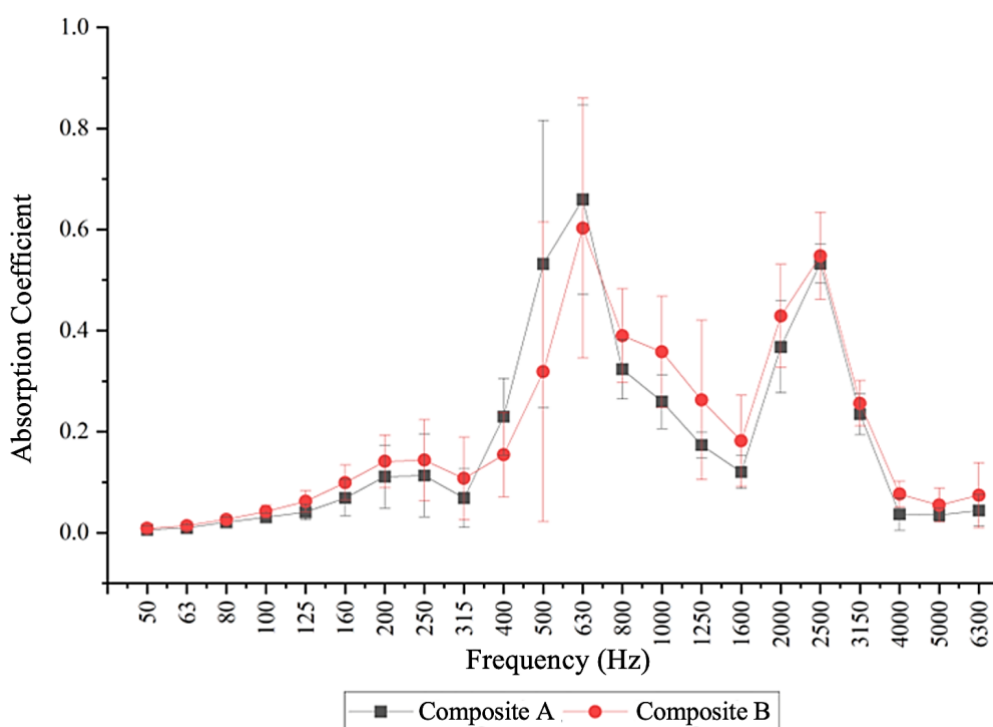


Figure 5. Graph of the absorption coefficient of composite A and composite B

A second absorption peak was observed at 2500 Hz, with composite A (maple) reaching 0.533 and composite B (mahogany) slightly higher at 0.548. These values indicate effective absorption in the upper mid-to-high frequency range, which is important for mitigating sharp and reflective sound components commonly found in indoor architectural environments [27]. Throughout the frequency range of 400 Hz to 3150 Hz, both TW panels consistently maintained absorption coefficients above 0.2, demonstrating stable acoustic performance across frequencies relevant to speech and ambient noise control. In contrast, the coefficients dropped below 400 Hz and above 3500 Hz, a typical limitation of thin membrane-type absorbers lacking hybrid enhancements, such as mass loading or tuned cavities.

5. Discussion

5.1 Structural Influence on Acoustic Behavior

SEM images (Figures 3 and 4) confirm the absence of surface and internal porosity in transparent wood, indicating that sound absorption is governed by membrane-based rather than porous mechanisms. This is supported by impedance tube measurements, where the inclusion of a 2 cm air gap enhances panel resonance, consistent with classical membrane absorber theory [24, 25]. In this configuration, the transparent wood acts as the vibrating mass, and the air cavity serves as the compliant spring.

Our previous study provides supporting data on density and elastic modulus [16], reinforcing the membrane resonance explanation observed in this study. Transparent maple and mahogany exhibited similar physical properties, with densities of 0.66 and 0.54 g/cm³ and elastic moduli of approximately 3.65 and 2.95 GPa, respectively. These values fall within the expected range, considering that the elastic modulus of pure epoxy resin typically lies between 2.83 and 3.35 GPa, while that of crystalline cellulose can exceed 10 GPa [28-30]. The measured values suggest that the mechanical behavior of transparent wood is primarily governed by the resin matrix rather than the cellulose phase, due to the high degree of lignin removal and complete resin infiltration. Although native differences in wood microstructure exist, the delignification and epoxy impregnation processes result in a homogenized, closed-cell composite. Consequently, acoustic performance is largely determined by macroscopic parameters such as surface mass, stiffness, and cavity interaction, rather than fine anatomical variation.

Based on the estimated surface mass and cavity depth, the resonance frequencies for the maple and mahogany TW panels were theoretically calculated using the simplified spring–mass model described in Section 2.3. By assuming a membrane thickness of 1 mm and bulk densities of 660 kg/m³ for maple and 540 kg/m³ for mahogany, the resulting surface mass densities are 0.66 kg/m² and 0.54 kg/m², respectively. With a fixed air cavity depth of 2 cm, the predicted resonance frequencies are approximately 522 Hz for maple and 577 Hz for mahogany.

These predicted values align reasonably well with the experimentally observed absorption peak at approximately 630 Hz. The slight discrepancy between the theoretical and measured frequencies can be attributed to several factors. First, the spring–mass model assumes idealized conditions such as perfectly clamped edges, a uniformly distributed mass, and negligible membrane stiffness. In reality, the epoxy-infused TW panels exhibit residual flexural rigidity, which effectively increases the system's natural frequency beyond the mass–spring prediction. Second, slight variations in panel thickness or resin distribution may introduce differences in surface mass that are not fully captured by the simplified calculation. Additionally, the model treats the air cavity as a lossless acoustic spring, whereas in practice, thermoviscous losses and structural damping within the panel and surrounding mount can influence the resonant response.

Despite these simplifications, the relatively close match between the theoretical and experimental frequencies suggests that the spring–mass model remains a valid and useful approximation for evaluating the resonance behavior of TW panels in a membrane absorber configuration. It serves as a practical design tool for tuning absorber parameters such as surface mass and cavity depth to target specific frequency ranges in architectural applications. While this study employed a fixed configuration, future research will investigate the effects of varying key parameters, such as cavity depth, membrane thickness, and pre-tensioning, to optimize absorption performance. Additionally, future work will include evaluation of porosity, flow resistivity, and development of theoretical absorption models to enhance predictive understanding and guide material design across specific frequency targets.

5.2 Comparison with Literature

To contextualize the findings of this study, it is essential to compare TW with other sound-absorbing materials reported in the literature. While traditional fibrous and porous absorbers rely on frictional dissipation through internal air pathways, recent advances have explored a broader range of mechanisms and structural designs, including membrane resonance and hybrid resonator systems. Depending on their internal architecture and constituent composition, these materials vary significantly in porosity, absorption behaviour, and frequency response.

Zhao, et al. [19] introduced a highly porous delignified wood known as *insulwood*, in which interconnected cellular channels enable efficient friction-based absorption. Zhang, et al. [31] enhanced mid-frequency performance by combining micro-perforated panels with a triply periodic minimal surface (TPMS) core, creating a hybrid resonance-friction system. Chen, et al. [32] demonstrated that porous fibrous metals can be optimized for broad frequency absorption by tailoring geometric and flow resistance parameters, supported by both theoretical modeling and experimental validation.

The present study positions transparent wood within this landscape as a low-porosity, epoxy-filled composite that functions effectively as a membrane-type acoustic absorber. Although it lacks interconnected pores, the TW panel exhibits pronounced absorption peaks due to resonance behavior when coupled with a controlled air gap. A summary comparison of these materials, highlighting their absorption mechanisms, porosity levels, and key performance metrics, is provided in Table 2.

5.3. Potential Modifications of Transparent Wood

Recognizing that the absorption capacity of transparent wood membranes is limited to a narrow frequency range due to the membrane panel mechanism, performance can be enhanced by applying the Helmholtz resonance principle or perforated panel strategies [33, 34]. By creating perforations designed based on specific resonance frequencies, sound absorption can be improved without compromising the material's transparency, one of the key advantages of transparent wood. Perforations introduce localized air resonance that works in conjunction with membrane vibrations, enabling the material to absorb sound more

effectively, especially at lower frequencies [21]. This hybrid mechanism expands the frequency range of effective absorption beyond what membrane action alone can achieve.

Table 2. Comparison of transparent wood with selected literature on acoustic absorption

Study	Material Type	Absorption Mechanism	Porosity	Peak Frequency	Key Contribution
Zhao, et al. [19]	Insulwood (delignified high-porosity wood)	Frictional dissipation via air–cell wall interaction	Very high (~93%)	~2,500 Hz	Demonstrates high acoustic and thermal performance from scalable porous wood
Chen, et al. [32]	Porous fibrous metal (multi-layer PFM)	Flow resistivity (JCA model validated)	High (engineered porosity)	~1700 Hz, 4500 Hz	Combines theory & experiment for fibrous-metal absorbers with tunable geometry
Zhang, et al. [31]	MPP + TPMS-Diamond sandwich	Helmholtz-type resonance + friction	Low–moderate (micro-perforated)	924 Hz, 1262 Hz	Introduces TPMS core for broader frequency bandwidth in hybrid resonator designs
This Study	Transparent wood (epoxy-filled composite)	Membrane resonance (spring–mass model)	Low (closed-cell, resin-filled)	630 Hz, 2,500 Hz	Establishes TW as a sustainable membrane absorber with a consistent acoustic response

A recent study by Jang, et al. [35] demonstrated that increasing the perforation ratio in birch plywood from 1.77% to 7.76% significantly enhanced its sound absorption performance, particularly in the low to mid-frequency range (125–500 Hz). The maximum absorption coefficient increased from 0.59 to 0.83, with the most efficient configuration observed at 5.77% perforation, yielding an NRC of 0.58. This corresponds to a nearly sixfold improvement in absorption over the unperforated sample, which achieved an NRC of only 0.10. These findings highlight the significant correlation between perforation ratio and acoustic response in wood-based panels. When compared with Composites A and B from the present study, the perforated samples exhibited broader frequency coverage and higher average absorption, indicating their greater potential as versatile acoustic materials for interior applications.

Future improvements may involve tuning cavity depth, modifying membrane thickness, or incorporating controlled micro-perforation, all of which have been shown to significantly influence resonance and absorption efficiency in membrane-type absorbers [36]. Similarly, the use of alternative polymer systems or graded porosity structures has been proposed to optimize broadband absorption [37].

6. Conclusions

Based on the research conducted, it can be concluded that transparent wood-based membrane panels have significant potential as sound-absorbing materials, with the ability to absorb more than 20% of sound in the frequency range of 400–3150 Hz. The highest sound absorption is achieved at a frequency of 630 Hz with an absorption coefficient value of 0.659 for composite A and 0.603 for composite B, and at a frequency of 2500 Hz with an absorption coefficient value of 0.533 for composite A and 0.548 for composite B. The sound absorption mechanism in transparent wood-based membrane panels follows the principle of the

membrane panel mechanism, where vibrations generated on the panel enable effective sound absorption. These results suggest that transparent wood has significant potential for use as an acoustic material in various construction and architectural design applications.

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