From Forest to Facade: Transparent Wood Fabrication and Characterization for Next Generation Green Building Application

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Abstract: Thermal insulation materials are growing in demand as global temperatures continue to rise as a result of climate change. Renewable, environmentally friendly, affordable, and highly effective thermal insulation substances are needed as one solution to this issue. Compared to other building materials like plastic, concrete, and glass, transparent wood has the potential to be a non-hazardous material. Transparent wood is a new and alluring substance that interests researchers and developers globally. Currently, considering engineering projects that requires green and energy-efficient construction, transparent wood has been acknowledged as a viable architectural and light-management promising sustainable material. Typically, materials have one of two properties i.e., structural or functional, but wood has the potential to be both structural and functional as a natural material. However, wood is an opaque material and due to the brown colored lignin content, it is not possible to see through it. Once, lignin is removed or modified then it can be applied to the functional transparent materials. Transparent wood has so many advantages over the traditional building materials. It is a good contender for use in energy-efficient buildings due to its efficiency, advantages, and scalable fabrication. Additionally, transparent wood has its aesthetic appeal, which has the potential to increase the relevance of a structure and improve the living conditions of its people. This innovative product has the potential to completely transform the engineering industry by providing an appealing and environmentally sustainable alternative to conventional building materials. Furthermore, transparent wood, an emerging technology in the field of wood science, is advantageous for purposes such as thermal insulation and energy savings in residential or commercial structures, since it ensures thermal comfort in the interior and is simpler to dispose after its service life. Currently, there are few ways for preparing transparent wood, including chemical process, which follows the delignification by using a lot of reagents and energy, and on another hand the physical process where lignin molecules can be broken down into smaller molecules. **[Objectives]** Thus, in this study a new green method for fabricating transparent wood was developed and efforts were attempted to modify the lignin chromophores wood veneer using solar-assisted UV rays and chemical brushing techniques. **[Method]** Wood veneers were brushed by chemicals namely NaOH (10 wt.%), followed by H_2O_2 (30 wt.%) and left the samples in the sunlight for UV illumination until the samples became completely white. In this process, a trace amount of NaOH was coated on the wood surface before brushing H_2O_2 to improve the oxidation efficiency of the H_2O_2. This procedure dramatically reduces the amount of energy and chemicals needed during processing, while preserving the majority of the lignin that acts as a binding agent and creating a sturdy wood scaffold for polymer infiltration. **[Results]** The physical and surface morphologies of wood specimens were assessed. To clarify the effects of

chemical treatment, the optical characteristics, particularly transparency, were tracked. In comparison to simply H_2O_2 brushed transparent wood, the produced NaOH and H_2O_2 chemically brushed transparent wood (0.6 mm in thickness) exhibits a high transmittance (65.31%). This is significantly higher than the transmittance of traditional wood, which is typically around 10%. Besides this, the weight percent gain for the prepared transparent wood sample was 300%, which ensures that it is much stronger than traditional wood. Additionally, the density of the prepared sample was 0.8 g/cm^3, however, this is a little bit lower while comparing with the traditional wood density, but within the range of the other conventional building materials. **[Conclusion]** Transparent wood manufacturing is a cutting-edge innovation with an opportunity to completely transform the building sector. It is a desirable replacement for conventional building materials due to its sustainability, aesthetic appeal, and prospective usage. It has the potential to be a key component in the upcoming wave of green building projects owing to its numerous advantages. Considering the technical point of view, the transparent wood can be fabricated and applied with big dimensions by following this simple modification technique. Moreover, the prospective applications of these types of substances might be found as a smart advanced building component in the upcoming decades with controllable illumination and possibly light-emitting competence when combined with relatively basic green production techniques.

Keywords: transparent wood; green method; large-scale fabrication; physical and mechanical properties; sustainability.