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Surface Treatment of Kawayan Tinik (Bambusa blumeana) using an Atmospheric Pressure Plasma System

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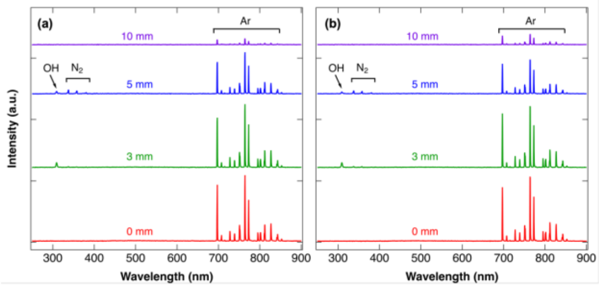
Recently, the market for wood furniture lost $200 million due to the lack of wood certification provided by the Forest Stewardship Council (FSC) and is projected to continue decreasing due to the reduced quantity of wood resources. Recent studies showed that bamboo, with its mechanical properties comparable to steel and greater than wood and its sustainability with a 3- to 5-year harvest process, can be a green alternative for the furniture industry. Although bamboo has many advantages, using it as a furniture material also has problems. Bamboo is vulnerable to mold infestation, its adhesion strength to water-based adhesives is low, and lastly, it is a flammable material due to its composition. Surface modification through different processes has been done to modify the surface properties of a material and achieve the desired property for different applications.

Cold Atmospheric Pressure Plasma (CAPP) treatment generated by argon (Ar) gas and dry air was utilized to modify the surface of the bamboo, specifically Bambusa blumeana (Kawayan Tinik). A computerized numerical control (CNC) atmospheric pressure plasma (APP) jet system was built to automate the plasma treatment of the bamboo slats in a raster motion to treat the surface of the bamboo uniformly. Optical emission spectrometer (OES) identified the presence of Ar, O_2, and N_2 peaks. The voltage and current igniting the plasma were also measured at ±4kV and ±50mA, respectively.



.Figure 1. Optical Emission Spectra of the plasma at different positions along the plume: (a) Ar only, (b) Ar+O_2

Fourier transform infrared spectroscopy (FTIR) confirmed that the polar groups on the surface of the bamboo were reduced by plasma etching, and the activation of O-H, or hydroxyl functional groups, was observed due to the presence of O_2 on the plasma; therefore, increasing its wettability. Plasma treatment was effective at converting the bamboo surfaces from hydrophobic (initial contact angle >77°) to hydrophilic (final contact angle <24°).

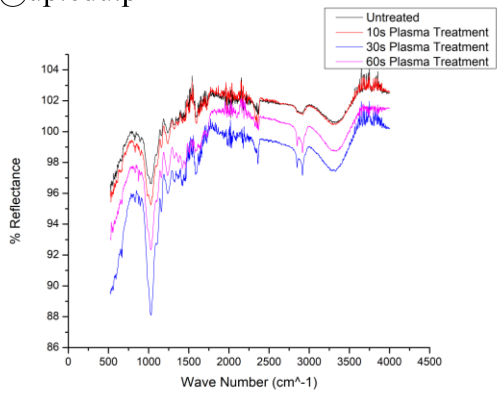


Figure 2. Fourier transform infrared spectroscopy of plasma treated and untreated bamboo surface.

Scanning electron microscopy (SEM) and Laser microscopy revealed that the morphological structure of the surface of the bamboo increased in roughness due to the plasma bombardment and etching.

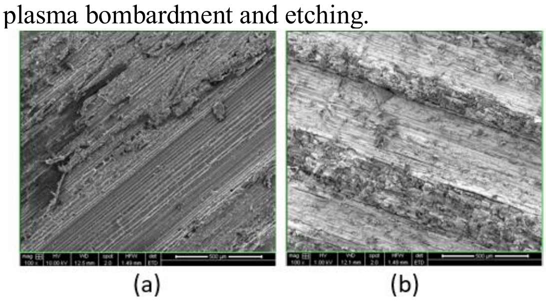


Figure 3. SEM images of (a) untreated bamboo surface and (b) 30s treated bamboo surface.

The mechanical properties of the plasma-treated bamboo showed a higher tensile strength than the untreated bamboo.

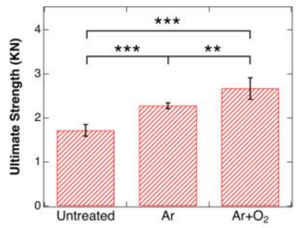


Figure 3. SEM images of (a) untreated bamboo surface and (b) 30s treated bamboo surface.

The research findings conclude that atmospheric pressure plasma treatment of bamboo improved its adhesion properties.

References

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