8th Asia-Pacific Conference on Plasma Physics, 3-8 Nov, 2024 at Malacca

Improving polyvinyl acetate adhesion strength on bamboo using plasma treatment

Bryndell J. Alcantara, Mark D. Ilasin, Marlo Nicole R. Gilos, and Magdaleno R. Vasquez Jr.
Department of Mining, Metallurgical, and Materials Engineering, College of Engineering, University of the Philippines Diliman
e-mail (speaker): mrvasquez2@up.edu.ph

Atmospheric pressure plasma systems have gained significant attention due to its simplicity, versatility, and cost-effectiveness. In addition, atmospheric plasma processes are generally considered safe for the operator and for the environment making it ideal for several applications. Plasma treatment can introduce physical and chemical changes on a surface without affecting the bulk properties of the treated material. One application of interest is to modify surfaces to improve adhesion such as wood and cellulose-based materials. Wood have played an important role in the construction industry. It is considered to have one of the lowest global warming potential [1]. However, the demand for wood continues to increase while the supply continues to decrease. This is because it takes several years for wood to grow. Hence, alternative materials to wood are being constantly being sought [2]. One alternative is bamboo since it matures within 3 to 5 years [3]. Recently, engineered bamboo products, are reducing the use of formaldehyde-based adhesives due to environmental and health issues. Thus, polyvinyl acetate (PVAc), a water-based emulsion, was considered as an alternative adhesive. However, the adhesive strength of PVAc with bamboo needs to be improved by increasing the hydrophilicity of the surface. To address this, an atmospheric pressure plasma jet system has been developed to treat bamboo (*Bambusa blumeana*) slats. The plasma jet has a 10 mm diameter nozzle and mounted on a raster scanning device. Argon (Ar) and Ar with dry air were used as the process gases ignited by a high voltage 20 KHz power source. Complete wetting of the bamboo surface was achieved after 60 s of treatment using Ar with air. When air is added, presence of reactive species was detected from optical emission spectral analysis. These species enhanced the functionalization of the surface with -OH leading to improved hydrophilicity as determined from Fourier transform infrared spectroscopy. The treatment induced a combination of physicochemical changes on the surface. To test the effectivity of the treatment, a single lap joint test based on ASTM D1002 of the bamboo slats showed a 55% enhancement of adhesion strength of plasma-treated bamboo slats compared to untreated bamboo slats as shown in Figure 1. The use of atmospheric pressure plasma for improving PVAc adhesion on bamboo is a promising method for producing sustainable wood alternatives with the least impact to the environment.

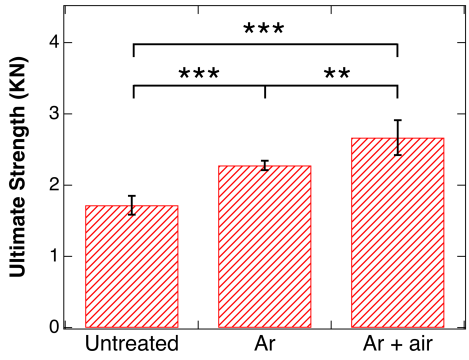

Figure 1. The ultimate strength of the untreated and plasma-treated bamboo slats.

The authors acknowledge the support of the UP Diliman Outright Research Grant titled “Enhanced adhesion of plasma-treated bamboo slats” (Project No. 171729 PNSE). The authors also acknowledge the research project SPARCS: System for Plasma-assisted Ablation of Residues and Cleaning of Surfaces under the DOST CRADLE program. M.R. Vasquez acknowledges the Felix M. Gonzalez Professorial Chair in Materials Engineering.

References

[1] A. Estokova and M. Porhincak, Clean Technologies and Environmental Policy 17 (2014) 75–83.
[2] M. Yadav and A. Mathur, Materials Today: Proceedings (2021)398 2872–2876.
[3] F. Tamolang, et al., Bamboo Research in Asia (1980) 189–200.