Surface Treatment of Mulberry Silk Fabric and Handmade Lokta Paper by Atmospheric Pressure Dielectric Barrier Discharge

G.K. Chhetri, R. Guragain, D. P. Subedi*,
Department of Physics, School of Science, Kathmandu University, Nepal
*e-mail:dsubedi@ku,edu.np

Thermal non-equilibrium plasma generated at atmospheric pressure are widely used in many applications because of their low cost and ease of operation and maintenance. Surface activation and modification of diverse materials is one of the most important applicationsof atmospheric-pressure plasma. In this paper, we report surface treatment of Mulberry Silk Fabrics (MSF) and Handmade Lokta Paper (HLP) by dielectric barrier discharge (DBD). A high voltage power supply operating at 50Hz was used to generate the DBD in air at atmospheric pressure. Electrical and optical diagnostics were performed for the characterization of the discharge. The effects of the plasma generated with an applied voltage of 11.6 kV (rms) on the hydrophilicity of woven silk fabric were studied using contact angle goniometry and attenuated total reflection Fourier Transform Infrared Spectroscopy (ATR-FTIR). The surface free energy of the sample was calculated using the Kwok-Neumann method using contact angle data. The gravimetric method was used to investigate the plasma-induced weight loss in the fabric sample. The effects of the plasma generate with an applied voltage of 12.8 kV (rms) on the hydrophilicity and weight loss (%) of HLP were studied respectively by the wicking test and gravimetric method.

The electron density and electron temperature were found to be 7.67×10^{14} m^{-3} and 1.01eV at an applied voltage 11.6 kV (rms) and 8.47×10^{14} m^{-3} and 1.07 eV at an applied voltage 12.8 kV (rms). The water contact angle on MSF was found to decrease from 120.4° to 40.7° after exposure to plasma, indicating an increase in the fabric's hydrophilicity. The results of water contact angle, surface free energy and ATR-FTIR confirmed that the exposure to DBD air plasma remarkably improved the hydrophilicity of fabric by incorporating chemical functional groups.

The wicking time to reach 7 cm height for untreated paper was 786 s, and it decreased to 486 s after the 2 minutes of plasma treatment. The wicking coefficients of 2 minutes and 10 minutes plasma-treated sample were respectively 1.28 times and 1.37 times greater than the wicking coefficient of the untreated sample. The wicking rate measurements showed that the hydrophilicity of the Lokta paper improves with treatment time, and a two-minute plasma treatment would be sufficient to improve its hydrophilicity effectively.

References:

1. K. V. Rani, N. *et alThe Journal of The Textile Institute*, 109(3):368–375 (2017).
2. C. W. Kan and W. S. Man.*Polymers*, 10(3):233, (2019)
3. R. B. Tyata, *et alPRAMANA, Journal of Physics, Indian Academy of Sciences,* Vol. 8, No. 3, pp 507-517, (2012).
4. D. P. Subedi, *et al*, Frontiers in Physics, AIP Conf. Proc. 1588, 103-108 (2014).

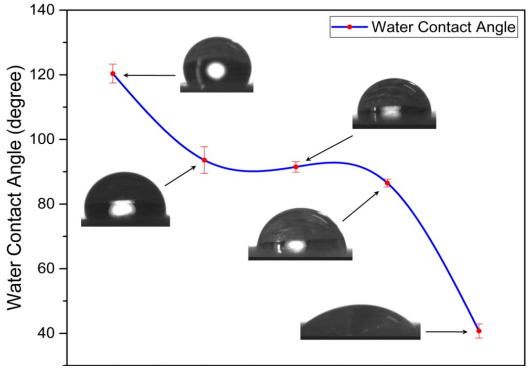

Fig 1. Water contact angle on silk surface as a function of treatment time in DBD.