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The Increased Durability of Natural Dye on the SiO₂-Modified Paper

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Cellulose, extracted from plant, has been widely used in various purposes especially in paper industry. In industry, cellulose is modified by many organic and inorganic substances in order to improve the quality like smoothness, whiteness and mechanical strength. However the deterioration of the paper according to the degradation of cellulose has been found in many ancient documents and paintings. The causes of cellulose alteration are from biodegradation, photodegradation, acid hydrolysis and oxidation. In this research, filter paper, a representative of cellulose fiber, was coated by SiO₂ to improve its stabilities. The surface of the cellulose was initially modified by various methods as follows:

1. esterification by polycarboxylic acids like tartaric acid (TA) and butanetetra-carboxylic acid (BTCA) to obtain FIL-TA and FIL-BTCA respectively
2. etherification by sodium monochloroacetate to obtain FIL-MCAA
3. coating by carboxymethylcellulose to obtain FIL-CMC

Then each of the modified filter papers was subsequently coated by SiO₂. All paper samples were characterized by SEM/EDS, XRD and TGA. The Smoothness (Bekk method), air resistance (Gurley method) and bursting test of paper were also performed. All coated papers were then placed in saturated curcumin solution for 20 min. The stability of this natural dye on the paper was tested against UV-A radiation ($\lambda = 315\text{-}400\text{ nm}$) for various time interval. The changes in the color parameters L, a, and b were measured; L index of color represents black-to-white color, a index represents green-to-red color, and b index represents blue-to-yellow color. The overall change in color indices of the coated papers can be calculated as the following equation:

$$\Delta E = ((\Delta L)^2 + (\Delta a)^2 + (\Delta b)^2)^{1/2}$$

where ΔL , Δa , and Δb are the differences between the values of the color indices before and after radiation. The TA-SiO₂ paper shows the lowest ΔE value.

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