A new kind of paper

by Luis Wilfrido Atienza

Crude kapok fibers were turned to paper as the final form of the material by researchers from the University of the Philippines Diliman and U.P. Los Baños. The researchers were looking for ways to treat wastewater.

The kapok (*Ceiba pentandra*) is a type of tree commonly found in tropical countries. One of its most notable traits is its large seedpods containing large amounts of cottonlike fibers, called kapok fibers. These fibers can be used as stuffing for pillows, mattresses, and other types of upholstery; they can be combined with other types of fiber to create cloth and textiles; and, because they can repel water, they are used in creating buoys and life preservers.

Being suitable to the Philippine climate as well as useful, kapok trees are cultivated by Filipino farmers. Kapok is easily obtained from local sources, and finding alternative uses for it, while addressing other pressing problems, would benefit local farmers.

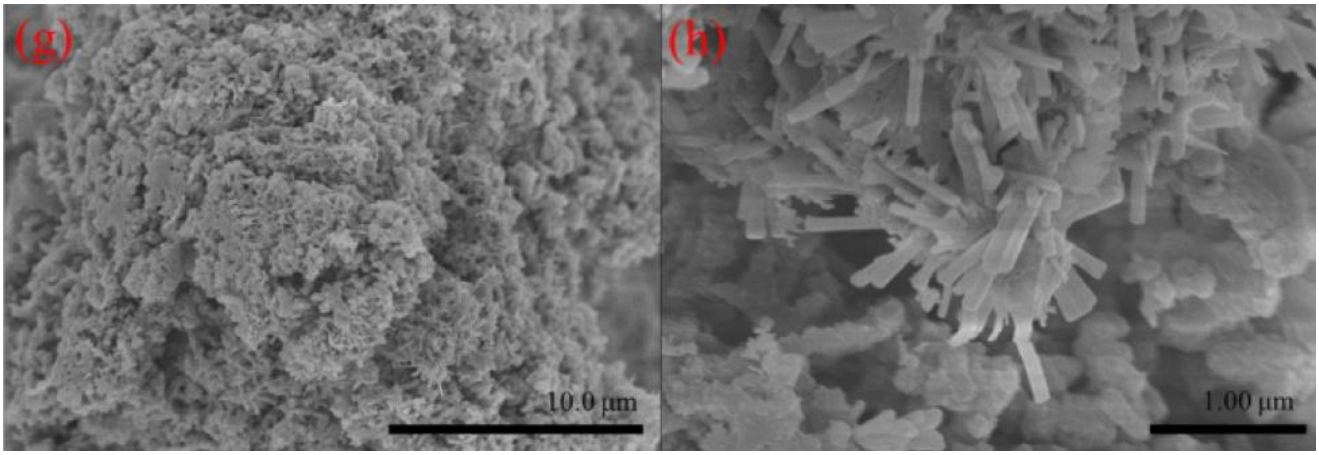
The researchers were looking into using specially treated kapok fiber as a way to treat wastewater, which can contain chemicals harmful to fish or other aquatic animals and even humans. Their work is published in *Surface & Coatings Technology*.

The researchers wanted to make use of a substance called polyaniline, or PANI. The adsorptive properties of PANI make PANI molecules highly attractive to certain other kinds of molecules, which stick to the PANI. Thus, PANI is useful for pulling substances, which can include harmful contaminants, out of water, helping purify the water. In particular, PANI is used for adsorbing organic dyes, which are common contaminants of industrial wastewater and can cause serious health risks in people and animals exposed to them. The researchers also wanted to use zinc oxide—a chemical that would react with the organic dyes as well as sunlight to break the dyes down into harmless substances—to purify the water further.

While PANI is effective for removing contaminants from water, it can be difficult to remove PANI itself once it is in the water it is meant to purify. This is why it is usually bound to a structure, allowing it to be easily taken out of the water after the treatment. This is where kapok fiber comes in.

The researchers wanted to figure out if PANI and zinc oxide—which would help break down organic dyes—could be bound to paper created from kapok fiber. Kapok fiber was chosen not only because it is easily obtained but also because it is tough and it repels water, making it ideal for retaining its structural integrity underwater.

The researchers first treated and pulped kapok fibers and used the pulp to create handmade pieces of kapok paper. Then they treated the paper with a zinc solution to allow zinc oxide to form on the paper and with aniline solution so that PANI would form as well.



An electron microscope image of the kapok paper with microscopic deposits of zinc oxide and polyaniline.

The researchers took the kapok paper, laden with zinc oxide and PANI, and immersed the paper in water contaminated with methyl orange dye. Methyl orange is mostly used to indicate the pH value of different substances. It is a chemical found in many laboratories, and it can end up in industrial wastewater. As an organic dye, it made a good substance to use to test the capabilities of the treated kapok paper.

Thus the final form of the material was paper created from crude kapok fibers, which incorporated microscopic deposits of zinc oxide and PANI.

To treat the methyl orange–contaminated water, the researchers immersed the paper in the water for 24 hours, with the water constantly being stirred the entire time. They created two versions of the test—one conducted in the dark, the other under ultraviolet (UV) light. This was to test how significant zinc oxide's reaction with sunlight would be to the purification process.

To determine how much methyl orange was removed from the water, the researchers used a machine called a spectrometer, which can detect very small changes in the concentrations of substances by how much light is able to pass through a solution. Comparing the two versions, the researchers found that after 24 hours the paper was able to remove roughly 70% of the dye in the dark and around 80% of the dye under UV light. This shows not only that zinc oxide's sunlight-driven reactions can play an important role in breaking down organic dyes but also that the researchers' entire method was a success.

From the creation of the kapok paper, to the treatment with zinc oxide and PANI, to the actual purification tests, this proof-of-concept method has the potential for purifying wastewater. Further research could apply this method to other organic dyes and water contaminants or even refine and optimize the process, making the treated kapok paper ready for real-life wastewater treatment applications.

REFERENCES

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