Safer Surfaces

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Many fields of science, like microbiology, genetics, and biochemistry require carefully-controlled sterile environments for work to be done in. Even a single misplaced cell could throw off the results of a study, or cause a procedure to fail, costing researchers time and potentially thousands of pesos.

This is why a wide variety of techniques for working with biologically sensitive samples and specialized kinds of equipment to handle them have been established. Many of these technologies focus on sterilizing and keeping bacteria away from surfaces that commonly come into contact with bacteria, like lab tables and instruments, including creating surfaces that naturally kill or repel bacteria.

This type of technology also has applications outside of the lab. Anti-bacterial surfaces can be deployed in public spaces, in doorknobs, handles, ATM keypads, and other surfaces that are handled by many people. This could help fight bacteria that can linger on these surfaces, reducing the spread of infections.

Researchers from the University of the Philippines Los Baños have been studying techniques for making and analyzing anti-bacterial surfaces. In a paper published in *Materials Chemistry and Physics*, they share their work embedding filter paper with copper compounds.

Copper compounds like copper sulfate and copper oxide are known for their anti-microbial properties, can remain effective in a wide variety of conditions, and are much cheaper than alternatives like silver. This made them ideal substances to use for embedding in a surface.

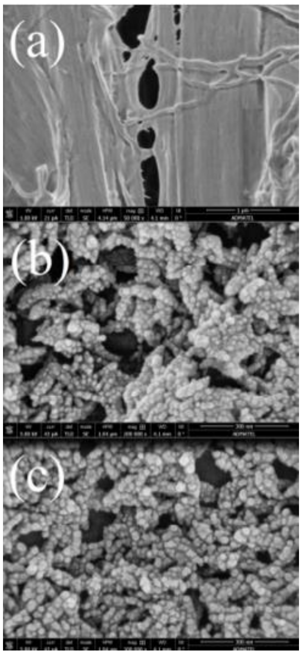
Because the process of embedding can be difficult for some surfaces, embedding copper in a flexible, surface like paper—which can easily be made into many shapes and sizes—can be useful. Anti-microbial paper can be used to cover a surface or object, easing a lot of the difficulty.

The researchers used two techniques to embed copper into the filter paper. The first method involved soaking filter paper in a pre-prepared copper sulfate solution, until the chemical was absorbed into the paper. This is called direct assembly.

The second method—called the *in situ* method—was used to incorporate copper oxide into the paper. In this method, the scientists create a chemical reaction to create copper oxide within the paper itself. They used paper from the previous procedure—which had been treated with copper sulfate—as a base, treating it with sodium hydroxide, which reacted with the copper sulfate, resulting in copper oxide.

After treating their paper with copper, the scientists had to determine how well the processes worked. While scientific tests can seem complicated or difficult to understand, many can be simple and intuitive.

Copper sulfate is a usually a bright blue, while copper oxide is usually brown. So to determine how well the copper compounds were embedded into the



The electrographs from the scanning electron microscope show regular filter paper (top) and filter paper with copper particles (middle and bottom).

paper, the researchers scanned the filter paper into a computer, and looked at how much of each paper turned blue or brown, as well as the intensity of each. This allowed the scientists a quick look at how well the copper was embedded into the paper.

The results of the image processing were positive and demonstrated how soaking filter paper in a copper solution could result in copper sulfate being incorporated into the paper. The researchers also tested if altering the concentrations of the solution and varying how long they would soak the paper for would change how much copper sulfate would be incorporated in the material. Increasing both these variables resulted in even more copper becoming embedded in the paper, as shown by the color analysis. It also showed that copper oxide could be embedded into filter paper *in situ*, following the procedure mentioned earlier.

The researchers also performed a more thorough analysis of the paper, using a scanning electron microscope, or SEM. An SEM is an incredibly powerful microscope, which the researchers used to visualize the particles of copper oxide embedded into the filter paper. X-ray diffraction—a technique that involves firing x-rays to crystals to characterize them—was also used to determine that the crystals were in fact copper sulfate and copper oxide.

After determining that the procedures were successful, the scientists tested their paper's ability to actually fight against bacteria and fungi, by placing samples of the paper in dishes along with the microorganisms, and determining how far away from the paper the bacteria or fungi needed to be to be able to grow. These tests showed that the copper sulfate filter papers were very effective against bacteria, while being slightly less effective against fungi. The copper oxide papers on the other hand were less effective against both the bacteria and the fungi.

There are many ways that this research and be built on, from finding more efficient ways to embed copper compounds into filter paper, finding other materials that can be embedded with anti-microbial compounds, finding ways to maximize the antimicrobial effects of these treated objects, and more. And whether in the lab, or out on the street, these bacteria unfriendly surfaces could mean much cleaner and safer lives for Filipinos.

REFERENCE

Cano AP, Gillado AV, Montecillo AD, Herrera MU. Copper sulfate-embedded and copper oxide-embedded filter paper and their antimicrobial properties. Mater Chem Phys 2018; 207(1):147-153.

Luis Wilfrido Atienza graduated from the Ateneo de Manila University, with a BS in Biology, and a minor in poetry. He currently works as a copywriter for a sustainable agency, and spends some of his free time writing about science.