Researchers find a new way to clear the air

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In 1999, then-Chinese Premier Zhu Rongji said that Beijing's pall of smog "would shorten my life at least five years," a hazard level scientists affirmed two years ago with a study of China's air pollution. That reality that did not sit well with Stanford University researcher Yi Cui, who makes frequent trips to China.

"The air pollution there is terrible," Cui said. "I decided we needed to do something about it."

He didn't realize it at the time, but a solution was in his gloved hands every day at his Palo Alto laboratory, where his team works on touch-screen and battery technologies.

Cui challenged his team at Stanford to come up with an approach that could make a dent in Beijing's lifespan-shaving smog. His researchers discovered that a mesh made from polyacrylonitrile, a chemical used to produce surgical gloves, had a remarkable appetite for air pollutants. They developed a thin filter that gobbled up even the smallest pollutants, and it could absorb many times its own weight in sooty particles.

"The chemical composition of the fiber here is the key," said fellow Stanford professor Lynn Hildemann, who was not affiliated with Cui's research. Other scientists have shown that small fibers are better at trapping air pollutants, but not using this material.

Now, Cui and his team hope their innovative approach can help clear the air by the lungful for people living in high pollution zones in Beijing and

beyond.

Even moderate levels of air pollution contribute to respiratory and cardiac ailments. In 2013, the International Agency for Research on Cancer classified outdoor air pollution as a cancer-causing agent. The most hazardous parts of air pollution are "fine particles," airborne chemicals and compounds smaller than 2.5 microns (about 1,000 times smaller than the smallest grains of sand). People in high pollution zones inhale fine particles deep into their lungs, where they can become lodged or even enter the bloodstream. The World Health Organization's Global Burdens of Disease project estimated that air pollution contributed to 3.2 million deaths worldwide in 2010, including more than 200,000 deaths from lung cancer.

From 2010 to 2012, the American Lung Association reported that more than 46 million people in the United States live in counties with unhealthy levels of particulate air pollution. The five worst metropolitan areas were Fresno, Visalia, Los Angeles, Bakersfield and Modesto.

Cui's team used a technique called electrospinning to create filters made from different industrial polymers, explained Stanford graduate students Chong Liu and Po-Chun Hsu. Electrospinning uses an electric field to pull a thick liquid polymer into thin threads just one-thousandth the width of a human hair and deposit them on a surface to dry.

Liu, Hsu and their colleagues tested how well different meshes, each made from a unique type of polymer, filtered particles in the air. Each polymer has its own chemical properties, which will affect how it will interact with pollution particles, Liu said. "How 'sticky' the surface is determines" whether a particular mesh will hold on to these pollutants, she added.

They exposed each mesh to simulated air pollution from an unlikely

source: burning incense.

The incense smoke had air particles of a similar size to the air pollution that plagues cities in northern China, including the fine particles that are the greatest threat to human health. The polyacrylonitrile mesh grabbed and held onto more than 99 percent of all the air particulates, including more than 98 percent of fine particles. The filter could collect up to 10 times its own weight.

"That actually surprised me," Cui said. "This filter is so efficient and takes in so many particles."

Cui's team didn't need to force air through the filter. The fibers in the mesh were so thin that air could flow through it and the polymer could seize pollutants as they passed. One member of Cui's team even took a polyacrylonitrile filter to China in July. He discovered that the filter removed 99 percent of pollutant particles from the air that passed through it on a hazardous air quality day.

The filters they made also were at least 70 percent transparent, which the scientists hope will make polyacrylonitrile filters an attractive option for window screens in homes and apartments.

"The sunlight can still come in," Cui said.

Current window filters lack this transparency and block out sunlight, said Al Veeck, executive director of the National Air Filtration Association.

"It utilizes the best of both worlds," he said. " It's using outdoor air and filtering it in a more natural setting."

The filter's thinness and transparency also could make it easy to incorporate into other devices to filter out pollutants.

"It might improve airflow in personal masks," Liu said.

Other researchers in Singapore, China and the United States also are trying to use electrospinning to filter pollutants and even pathogens from air and water. Nanofibers currently are used in some commercial air and water filters, but in conjunction with other filtering technologies, Veeck said. In principle, Cui's approach to air filtration also could gobble up air pollutants closer to their emission sources, including cars, power plants and industrial centers. However, those filters must be durable enough to withstand high temperatures and harsh chemicals. Cui plans to continue working on new air filters for industrial, commercial or residential settings.

There is certainly an urgent need for solutions, said Liu, who frequently visits her native China.

"We all see this heavy haze when we go," she said. "It's really serious now."