The humble Knoxville scientist who became a worldwide hero

By Vincent Gabrielle
Knoxville News Sentinel

KNOXVILLE, Tenn. (AP) — I started getting calls for help late in March. Messages came in through e-mail and Twitter from healthcare workers who were feeling desperate because their supply of personal protective equipment was dwindling.

"I'll keep this short and sweet. I'm a nurse and we are scrambling for PPE," wrote one nurse.

But they weren't really asking for me. They were asking to be put in touch with one of my sources, Dr. Peter Tsai of Knoxville. He responded quickly to these calls for help, even late at night.

Before the coronavirus pandemic, Tsai was far from a household name. Even though he was well-respected as a materials scientist and inventor, very few people had heard of him.

Until now.

COVID-19 had dragged one of Tsai's inventions into the spotlight. He is the creator of the filter material inside most disposable N95 respirators. As the pandemic worsened, healthcare workers nationwide needed the masks to stay safe, which means there were shortages and massive price markups.

The shortage was so dire that it brought Tsai out of retirement to dive head-first into solving the crisis.

Since mid-March, Tsai has been a worldwide force on two fronts — finding new ways to sterilize disposable respirators for reuse and rapidly scaling up their production.

"My invention is just an ordinary invention," the 68-year-old said humbly in an interview with Knox News. "But because of the need for the respirators, people think it is very important."

Tsai's invention is not new. He filed the first patent for the filtration technology back in 1995. His invention gives the masks' filter fabric a permanent electrostatic charge by exposing it to a halo of electricity. Scientists call this an electrical "corona." Tsai named his process "coronal charging."

The coincidence between the names is not lost on Tsai.

"I use coronal charging to fight coronavirus," he joked.

Tsai has had a long career in textile manufacturing and engineering. He graduated in 1975 from what is now National Taipei University of Technology. He worked for several years in manufacturing before moving to the U.S. in the 1980s to obtain a doctorate in materials science at the University of Kansas.

During his research career at the University of Tennessee Knoxville, Tsai developed his filtration technology further while pursuing other projects. He holds 12 U.S. patents in filtration technology and other areas.

While his material and production processes made a huge difference in the world, it wasn't front-page news. He retired in late 2019. Then you know what happened this year.

"I felt very stressed in the very beginning," he said. "I got a lot of pressure and a lot of questions."

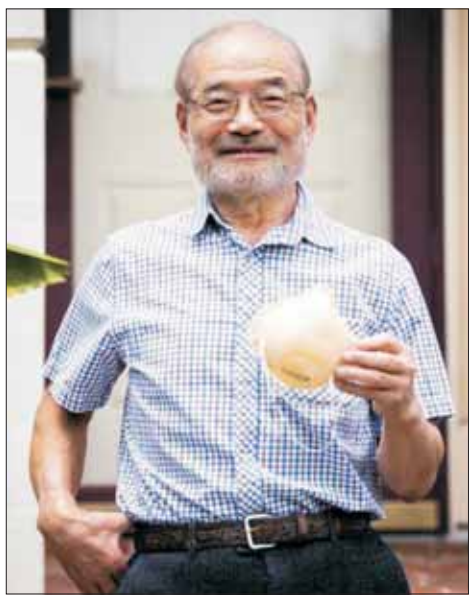
He knew the kinds of stress the respirators could tolerate, and he published these thoughts in the *Journal of Emergency Medicine* in a special emergency article. He turned his home into a lab and published more results.

One group donated an ozone machine commonly used in hospital sterilization to see if that would work. Tsai boiled and steamed masks. He borrowed a neighbor's oven to see if masks could be safely heated using common kitchen appliances. He exposed respirators to sunlight. The masks were then tested again to see if they lost filtration power.

Ozone was a no-go because it ruined elastic or rubber ear loops. Wet heat had to be applied carefully to avoid deforming the masks. Home ovens heated too unevenly and inaccurately. Alcohol ruined the filters. Other techniques, like dry heat and hydrogen peroxide, seemed more promising.

But Tsai couldn't fully test every technique, nor could he validate that it killed viruses. This worried him.

"I started wondering whether people were using my methods without validation," Tsai said. "If it does not really sterilize the mask and people reuse them, then we would have a lot of trouble."



MASK MAVEN. *Since mid-March, Peter Tsai, the inventor of the N95 filtration material, has been a worldwide force on two fronts — finding new ways to sterilize disposable respirators for reuse and rapidly scaling up their production. (Brianna Paciorka/*Knoxville News Sentinel *via AP)*

He reached out to other scientists and got in touch with a team at the University of Tennessee Medical Center to validate his approaches. N95DECON, an interdisciplinary research group, also got in touch. It ran its own tests to validate some of his suggestions in addition to others.

N95DECON recommends versions of some of Tsai's initial approaches for sterilization. Its validation studies cite communications with Tsai and the experiments of over a hundred N95DECON members. Their results echo some Centers for Disease Control and Prevention suggestions for mask sterilization.

But reusing masks is only half the battle.

The world faces a critical supply shortage. Few domestic suppliers make N95 filtration material. Half the world's N95 masks are manufactured in China. The Food and Drug Administration recently deauthorized many models of N95 masks from being reused.

Unbeknownst to Tsai, Oak Ridge National Lab (ORNL) was gearing up to try to address the problem.

"We have a lab-wide initiative effort on COVID-19," said Dr. Merlin Theodore, director of the Carbon Fiber Technology Facility at ORNL. She explained that the facility was struggling to come up with a way to convert its machines to make the filter fabric and was looking to enlist local experts.

Dr. Lonnie Love, a lead scientist in ORNL's COVID manufacturing task force, remembered Tsai but couldn't put his finger on why.

"He remembered the name and couldn't remember why so he asked his wife," Theodore said. As it turns out, Tsai was neighbors with Love's mother-in-law. After that, they quickly made contact.

"He came that very same week, fully suited up. He brought his own equipment," Theodore said. "He reminded me of someone going to war."

With Tsai's expertise, the team at ORNL was able to quickly convert its carbon fiber processing facility into a filtration cloth facility. Within a week it was able to produce filter cloth. Theodore says it's impossible to say how much time Tsai's involvement saved.

"Just imagine the amount of experiments you'd have to run to determine a process that works," Theodore said. "That can average from months to years. But we didn't have to because he had already done all the experiments."

The ORNL facility can produce enough material for roughly 9,000 masks per hour. It's shipping the material to academic and national labs for research purposes. Theodore explained that for the market, ORNL worked with industry partners to

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