COVID Information Commons (CIC) Research Lightning Talk

Transcript of a Presentation by Franchessa Sayler (ThruPore Technologies), September 22, 2021

Title: SBIR Phase I: Antiviral Activity of Novel Nitrogen-Doped, Carbon Supported Catalysts Against Covid-19 Surrogates

Franchessa M Sayler CIC Database Profile

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YouTube Recording with Slides

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Transcript

Slide 1:

So, I am the president and CEO of ThruPore Technologies. We were awarded last year an NSF [National Science Foundation] grant a Phase one SBIR [Small Business Innovation Research] grant to investigate the Antiviral Activity of Novel Nitrogen-Doped, Carbon Supported Catalyst Against COVID-19 Surrogates.

Slide 2:

Just to summarize my talk briefly. I'm going to go over current air filtration solutions, the capture technology that they use through force technology, and the actual efficacy studies that we did against viruses and bacteria.

Slide 3:

So, just a review of particles of different sizes modern day air filters HVAC filters are designed to capture mostly larger particles. They specifically focus around this dust particle size 2.5 micron and above is our particles that they're very good at catching. Unfortunately, the coronavirus and other viruses are within the more difficult to capture size range which ranges from approximately 1 micron to about 0.3 microns.

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So, prior to COVID, most air filters that were used in let's say office buildings, small businesses, places like that you would generally use a MERV [minimum efficiency reporting value] 6 to a 10 braided air filter and most of the air was recirculated and it only- the system only diluted the air about 20 percent. Since the pandemic has started, now ASHRAE [American Society of Heating, Refrigerating and Air-Conditioning Engineers] is recommending these MERV 13 rated air filters that will capture a little bit more of those particles in that size range and also 100 percent outside air. Of course, this is not good for your HVAC system. It does provide more- it just does cause more stress on the system. It uses more energy. And then you also have the HEPA [high efficiency particulate air] filters which are not designed for you know for use in everyday systems.

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The HEPA technology, however, it's very unique it's completely different. You don't really get passed through the air filter itself. You have the airflow that passes over the plates. So, when you have particles in that 1 micron to 0.3-micron size range, they don't actually move in a linear fashion like other sized particles both larger and smaller. They, in fact, move randomly using a Brownian motion so designing a HEPA filter where you have air move over these plates allows for that Brownian motion to occur and you get more capture. This does make the air filter itself more efficient, however, it's pretty thick and so if anybody in here has a HEPA filter the- you know- I have the system themselves but then generally they're within smaller room units, you'll notice that they're pretty loud. It takes a lot of force to pass air over all of those plates, and again they are not recommended for use in a regular HVAC system.

Slide 6:

So, what ThruPore does is we make Porous Carbon. We make uniquely Porous Carbon it's approximately 90 percent porous. So, if you were to zoom in on the carbon itself you'll notice that it has this tortuous forest structure and in fact these ligaments are also porous.

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So, what we've been able to do is we- this is purely synthetic carbon so we are able to control the purity but also, we can add dopants and things like that to really control what kind of catalytic reactions occur. So, prior to COVID, we were we've mainly been enabling new reactions. We have worked with the U.S. Army Corps of Engineers to develop a munitions waste degradation catalyst. We've worked with various other companies to increase- to make a heterogeneous solid, or, sorry, fixed bed coupling reactions scale those up and we've also commercialized plastic waste upcycling reactions. And what's unique to our material is that the more material you have that flows through the catalyst, you get more product. So, we have higher yields. We're able to really get very few side reactions. We can really focus in on exactly the reaction that you want to occur. So, when COVID began to start happening, we started thinking about our product and by training as a chemist the first thing I thought of was: is there some sort of oxidative reaction that we could in fact enable to you know destroy these viruses among other things at room temperature?

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So, we received the NSF grant to further investigate this. So, our first and quite successful catalyst that we tried was a zinc oxide catalyst and it's very benign. It's found in infant diaper cream as well as sunscreen and it works by various different mechanisms so it does release reactive oxygen species as well as zinc ions and would actually degrade the bacteria or an enveloped virus by directly contacting the membrane.

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So, we started using what for testing we looked at the EPA [United States Environmental Protection Agency] approved COVID viral surrogates so specifically Bacteriophage MS2. The EPA has a viral hierarchy where it looks at things that are more difficult to destroy versus things that are easier to destroy from an oxidative type of perspective and MS2 is considered to be a small non-enveloped virus, so they consider it more difficult to destroy than SARS-CoV-2.

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So, with our testing, we used a nebulizer to nebulize these viral particles to kind of simulate a cough type of situation and we used an EPA adapted method 1602 to detect these viruses in a water sample after they were to pass through the filter themselves.

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Then, that water sample was diluted tenfold seven times to produce serially diluted samples and that allowed us to actually count and determine the exact amount of virus that was present both before the filter was treated and then after a solution were to pass through our vapor and then we would count placques which would indicate specifically we had a culture of E. coli and we would count viral plaque so anything that was considered active and any viruses that were active and present they would kill the E. coli and produce a hole in a viral plate.

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So, the data is actually- this is the data that we in fact submitted to the EPA and as you can see we have four and five nine efficacy so that is greater than 99.99 percent reduction of viral plaques. We also see the same efficacy in another bacteriophage that is approximately 0.3 microns which is called a T4 Bacteriophage.

Slide 13:

Here's a picture of the plaques that I was discussing. So, as you can see an untreated filter you have a lot of these viruses that in fact do get through whereas with ours, a treated filter, you see very few viruses survive and get through to kill that E. coli off.

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We also looked at E. coli and found that we in fact stopped 100 percent of these bacterial cultures which at that point we weren't quite sure- we wanted to make sure that we were killing bacteria and not just capturing bacteria so we started looking into doing timed kill studies where we added the catalyst directly to a culture.

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And here is some data from that study and as you can see after about 10 minutes we get a decent- we get about 70 percent reduction in the amount of bacteria that is viable, but after two hours, we get zero percent of bacteria that is viable. So, we were able- we've done further studies and we've actually been able to specifically find the exact milligrams of active ingredient, which is the zinc oxide per colony forming unit. So, we further went on to test this with Staphylococcus aureus and also Klebsiella pneumoniae. So, this is something that the EPA- these are considered hospital-acquired infections so they're very interested in these and what they wanted us to specifically make sure that our catalyst would kill these as well, and they do, and it doesn't.

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So, with that I'd like to conclude and just go ahead and announce that our final product developed does in fact kill greater than 99.99 percent of aerosolized viruses and bacteria, and I'd like to thank the National Science Foundation for funding the initial work and then we've also had follow-on funding through Newcastle County, Delaware, as well as the State of Delaware, to further scale up this product and get it out there. So, we are in fact selling air filters directly coated with our product called we call it Dr. Filter so you can see our website drfilter.com and we are looking currently for an air filtration partner so that we can really get more of this product out there. Thank you.