Nanoveu Limited
U1, 18 Olive Street
Subiaco WA 6008
+61 8 6244 9095
www.nanoveu.com

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ASX: NVU

Licensing Agreement with NTU Singapore

Nanoveu enters into a Licensing and Research Collaboration Agreement with Nanyang Technological University *Singapore ("NTU Singapore"), marking further progress in Nanoveu's strategy to create a full range of effective self-disinfecting solutions and expand the Nanoshield™ range of products.*

Highlights

- **Licensing and Research Collaboration Agreement with NTU Singapore, following the successful development of a new spray formulation for enterprise scale antiviral and antibacterial textile treatment.**
- **The spray provides significant market opportunities, as it allows the Company to coat textiles, fabrics and irregular shapes which cannot be coated with Nanoveu's existing Nanoshield™ film.**
- **The spray will be launched over the coming weeks, with the parties currently exploring the large-scale deployment of the technology, and discussions have commenced with interested parties globally.**
- **Nanoveu and NTU will also develop new products incorporating the spray, including facemasks to be sold into the Singaporean market, as well as other textiles products.**
- **The spray will be manufactured in Singapore.**
- **Initial lab reports demonstrate a rapid effect against Staphylococcus aureus (bacteria).**

Nanoveu Limited ("**Nanoveu**" or the **"Company"**) **(ASX: NVU)** is pleased to announce that the Company has entered into a Licensing and Research Collaboration Agreement (**"Collaboration Agreement"**) with Nanyang Technological University, Singapore, ("**NTU**") for the development of a new range of antiviral and antibacterial spray solutions.

The Collaboration Agreement follows the successful development of a new spray formulation, which allows the Company to coat textiles, fabrics and irregular shapes which cannot be coated with Nanoveu's existing Nanoshield™ film.

The parties are currently exploring the deployment of the technology for enterprise scale textile treatment, with Nanoveu aiming to launch the product over the coming weeks.

Under the Collaboration Agreement, Nanoveu will work with NTU Singapore on the development of copper-based active ingredients to create a new range of spray products.

The Collaboration Agreement is for a term of 5 years with options to extend.

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Efficacy Testing:

Laboratory testing demonstrated a 95.49% reduction of Staphylococcus aureus (bacteria) within 45 seconds[1].

The copper-based spray has also demonstrated the ability to withstand 120 machine washes and is suitable for coating a range of textiles and surfaces.

These products will sit alongside the existing Nanoshield™ film portfolio. Its antiviral technology has been independently demonstrated to be a highly effective agent for the inactivation of viruses and bacteria and has been referenced in peer reviewed reports in the American Journal of Microbiology. The technology has been proven to eliminate 99.99% of SARS-CoV-2 (COVID-19), HCoV-299E and OC43, within 15 minutes[2].

The Collaboration Agreement with NTU marks Nanoveu's continues Nanoveu's history of working with with Singapore's leading academic and research institutions.

Commenting on the Collaboration Agreement, Scott Beeton, Non-executive Chairman of Nanoveu said: "*Our Agreement with NTU is aligned with our strategy and commitment to developing a broad range of self-disinfecting proprietary products that help meet the demands of customers at home, work, and in public areas. Importantly, the recently developed spray has demonstrated a rapid and long-lasting antimicrobial effect opening significant market opportunities, as it allows us to coat textiles, fabrics and uneven surfaces which cannot be coated with Nanoveu's existing Nanoshield™ film.*

"The development of the spray is a further example of Nanoveu's success in establishing partnerships with leading institutions. We look forward to working closely with Professor Lam Yeng Ming and her team as we seek to share expertise in working with regulators, manufacturers, distributors and our customers to create an effective solution to control the spread of COVID-19 and other pathogens."

Professor LAM Yeng Meng, Chair of the NTU's School of Materials Science and Engineering commented: *"We are excited that Nanoveu is licensing our home-grown antimicrobial technologies, and with NTU's track record in innovation and Nanoveu's industry knowledge, we look forward to a fruitful partnership and turning these solutions into effective antiviral products that can contribute to Singapore's fight against the COVID-19 pandemic."*

- Ends -

This announcement has been authorised for release by the Board of Directors.

For further information, please contact:

Alfred Chong
Managing Director
t: +65 6557 0155
e: info@nanoveu.com

For media / investor enquiries, please contact:

Jane Morgan
Investor Relations
t: 0405 555 618
e: jm@janemorganmanagement.com

[1] For testing performed and the results, please refer to the test report appended.

[2] See ASX Announcements of 15 April 2020, 5 May 2020, 25 May 2020, 18 February 2021 and 28 July 2021 for the testing performed and the results.

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About Nanoveu Limited

We are technology innovators who specialize in modern, cutting-edge nanotechnology that improve the way we live, from reducing contagious transmissions on high touch points to immersive vision-based entertainment. https://www.nanoveu.com/

Nanoshield - is a film which uses a patented polymer of Cuprous embedded film to self-disinfect surfaces. Nanoshield antiviral protection which is available in a variety of shapes and forms, from mobile screen covers, to mobile phone cases and as a PVC commercial film, capable of being applied to a number of surfaces such as doorhandles and push panels. The perfectly clear plastic film contains a layer of charged copper nanoparticles which have antiviral and antimicrobial properties. This technology is also being applied to fabric applications targeting use in the personal protective equipment sector.

EyeFly3D - is a film applied to digital displays that allowed users to experience 3D without the need for glasses on everyday mobile handheld devices.

Customskins - are vending machines capable of precisely applying screen covers to mobile phones with an alignment accuracy of 150 microns.

EyeFyx - currently in research and development stage, EyeFyx is a vision correction solution using hardware and software to manipulate screen output addressing long-sightedness without the need to wear reading glasses.

Forward Looking Statements

Statements regarding plans with respect to Nanoveu's projects and products are forward looking statements. There can be no assurance that Nanoveu's plans for its projects or products will proceed as expected and there can be no assurance of future sales.

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Antibacterial assessments

Bacterial strains. For this investigation, carbapenem-resistant hypervirulent *Klebsiella pneumoniae* ENT646[1], laboratory stock strain *Pseudomonas aeruginosa* PAO1, and *Staphylococcus aureus* ATCC strain SA29213 were used.

Determination of antibacterial activity. Following the inoculation of bacterial cultures onto the fabrics for specific duration, fabrics were clipped to the lid of an Eppendorf tube and centrifuged at maximum speed for 1 minute to retrieve the liquid absorbed by the fabrics. Then the fabrics were washed in sterile phosphate-buffered saline to retrieve adherent bacteria, if any. The resultant solution from the fabrics and wash solutions were serially diluted and plated on lysogeny broth (LB) agar and incubated at 37 °C overnight. Percentage killing was calculated by comparing bacterial numbers obtained from fabrics treated with the copper nanoparticle formulation to the average bacterial counts obtained from control fabrics, according to the formula:

$$100 - \left(\frac{counts\ from\ the\ fabric\ of\ interest}{average\ counts\ from\ control} \times 100\right)$$

For experiments with repeated inoculation of bacteria, 10^4 CFU of one of the bacterial strains (i.e., *Klebsiella pneumoniae* ENT646) were inoculated sequentially, as described above, thrice a day for five consecutive days. At each timepoint, bacteria were retrieved from fabrics for the determination of bacterial numbers and percentage killing as described above. To image the change in bacterial morphology due to the interaction with the copper nanoparticle formulation-treated substrates, fabrics inoculated with 10^8 CFU of *Klebsiella pneumoniae* ENT646 for 1 hour were fixed in 4% paraformaldehyde for 15 minutes and washed in 10 mM glycine twice before three washes in deionized water. After overnight drying in a desiccator cabinet, the fabrics were then imaged with the scanning electron microscope.

Formula to convert percent reduction to log reduction:

$$L = -(log_{10}(-P/100 + 1))$$

Formula to convert log reduction to percent reduction:

$$P = (1 - 10^{-L}) \times 100$$

where L is the log reduction and P is the percent reduction.

Statistical Methods. Statistical significance of 95% confidence between three or more groups was determined by ANOVA followed by Tukey's test. All statistics were conducted using the GraphPad Prism software. Statistical significance is indicated as follows: *P ≤ 0.05; **P ≤ 0.01; ***P ≤ 0.001.

Washing assessments

For washing durability measurements, the protocol described in *Nano Materials Science* 2 (3) (2020) 281–291 was followed.[2] The washing time of six hours (360 minutes) was adopted. One washing cycle corresponds to approximately three minutes in the aqueous detergent solution in the ultrasound bath at 45 °C. Therefore, washing the copper NP formulation-treated substrates for six hours (360 minutes) corresponds to approximately 120 washes.

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Report

The results of the bacterial killing efficiencies after fabric interactions with *K. pneumoniae*, *P. aeruginosa*, *and S. aureus* for 45 seconds are presented in Table 1. The protocol described above was followed.

Table 1. Killing efficiencies obtained after copper NP formulation-treated fabrics interactions with *K. pneumoniae*, *P. aeruginosa*, *and S. aureus*.

Bacteria			**Bacterial killing in 45 seconds**		
			F#1	F#2	F#3
Gram-negative	*K. Pneumoniae*	% killing	99.91 ± 0.06	100.00 ± 0.00	-
		Log Reduction	3.0	6.0	
	P. Aeruginosa	% killing	95.58 ± 3.80	97.44 ± 0.89	-
		Log Reduction	1.4	1.6	-
Gram-positive	*S. aureus*	% killing	-	-	95.49 ± 1.92
		Log Reduction	-	-	1.3

The integrity and performance of the copper NP formulation-treated fabrics on washing was examined using attenuated total reflection Fourier-transform infrared spectroscopy, water contact angle, and scanning electron microscopy. The results can be found in Table 2.

Table 2. Copper NP formulation-treated fabrics showed no structural changes on extensive washing in aqueous detergent solution for a 6-hour period at 45 ^{o}C.

Substrate	**Substrate integrity**	
	t = 0 hours	t = 6 hours (~120 washes)
Fabric #1	OK	OK
Fabric #2	OK	OK
Fabric #3	OK	OK

References

(1) Chen, Y.; Marimuthu, K.; Teo, J.; Venkatachalam, I.; Cherng, B. P. Z.; De Wang, L.; Prakki, S. R. S.; Xu, W.; Tan, Y. H.; Nguyen, L. C.; Koh, T. H.; Ng, O. T.; Gan, Y.-H. Acquisition of Plasmid with Carbapenem-Resistance Gene blaKPC2 in Hypervirulent Klebsiella pneumoniae, Singapore. *Emerging infectious diseases* **2020,** *26* (3), 549-559, DOI: 10.3201/eid2603.191230.

(2) Agrawal, N.; Low, P. S.; Tan, J. S. J.; Fong, E. W. M.; Lai, Y.; Chen, Z. Durable easy-cleaning and antibacterial cotton fabrics using fluorine-free silane coupling agents and CuO nanoparticles. *Nano Materials Science* **2020,** *2* (3), 281-291, DOI: https://doi.org/10.1016/j.nanoms.2019.09.004.

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