



ASX ANNOUNCEMENT
(ASX: NVX)

9 June 2020

ADVANCED CATHODE MATERIAL MANUFACTURING METHOD – PATENTED BY NOVONIX

NOVONIX Limited (ASX: NVX) (“NOVONIX” or “the Company”), in partnership with the Professor Mark Obrovac Research Group at Dalhousie University, is pleased to announce its ability to manufacture “single crystal” NMC cathode material (“**Single Crystal Cathode**”) using its proprietary **Dry Particle Microgranulation (DPMG)** technique.

Single crystal cathode materials have recently become an aspiration for the lithium-ion battery industry, with demonstrated outperformance over traditional polycrystalline cathode particles (the current standard), enhanced energy density and ultra-long life for EV and ESS uses. Single crystal cathode cells far exceed the lifetime of other NMC/graphite cells (J. Dahn et al, Journal of The Electrochemical Society, 2019).

NOVONIX’s **Single Crystal Cathode** announcement today follows the Company’s release on 15 May 2020 of the breakthrough **DPMG** technique and related patent applications filed by NOVONIX, and further demonstrates the commercial application of DPMG.

NOVONIX Managing Director, Phil St Baker commended the Obrovac (Dalhousie) team for deploying the proprietary DPMG technology to develop the new Single Crystal Cathode materials and processes, with the objective of lower-cost, higher-performance battery materials.

He said the battery material innovations have the potential to deliver breakthrough step-change improvements in cost, performance and sustainability within the battery, electric vehicle and renewable energy sectors.

“The Single Crystal Cathode development complements NOVONIX’s PUREgraphite anode product, both addressing the ultra-long-life battery performance requirements critical to the achieving the million-mile battery life being sought by leading EV automakers,” he said.

The significance of single crystal cathode was highlighted in The Journal of The Electrochemical Society, with a paper published by Professor Dahn and his team stating: “We conclude that cells of this type should be able to power an electric vehicle for over 1.6 million kilometres (1 million miles) and last at least two decades in grid energy storage.”

The Single Crystal Cathode materials and manufacturing methods were developed within Professor Obrovac’s group through research funded by NOVONIX BTS in partnership with the Canadian government through the NSERC Industrial Research Chair Program. Under the commercialization arrangements with Professor Obrovac and Dalhousie University, NOVONIX BTS owns the intellectual property rights to the new Single Crystal Cathode technology on an exclusive and royalty-free basis. NOVONIX BTS has filed a further patent application to protect these new Single Crystal Cathode methods and the materials that can be synthesized by these new dry manufacturing processes.

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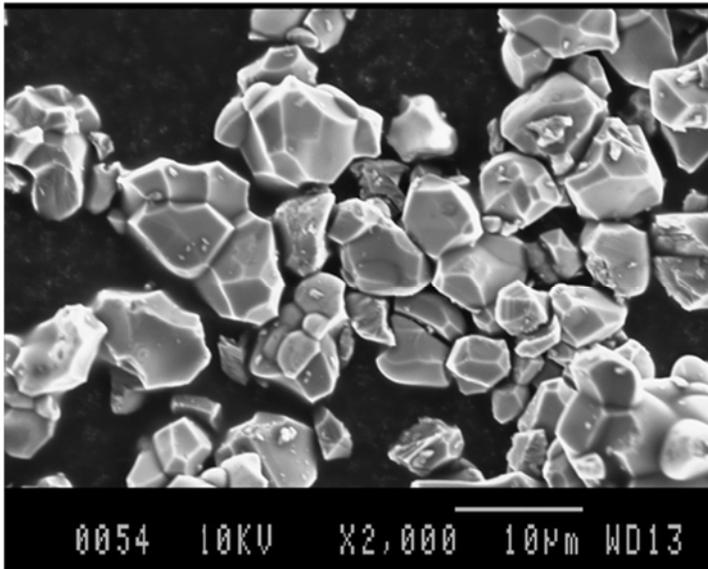
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Studies published by the Professor Jeff Dahn Research Group at Dalhousie University have demonstrated superior performance of single crystal cathode particles in head-to-head comparisons with polycrystalline materials [DOI: 10.1149/2.0991707jes] published 23 May 2017. The Dahn Research Group has more recently demonstrated the value of single crystal NMC532 to support the Dahn Group's "million-mile battery" project [DOI: 10.1149/2.0981913jes] published 6 September 2019.

Dr. Chris Burns, CEO of NOVONIX BTS, said this independent research indicates the potential of the commercial opportunity in cathode materials for NOVONIX's newly developed DPMG technique and its proprietary Single Crystal Cathode material.

"After discovering the possibility to dry-synthesize cathode particles with polycrystalline structures using DPMG, the team immediately thought about how to use this technique to also make single crystal particles. At NOVONIX BTS we work with various NMC and NCA-style cathodes and continue to find that single crystal materials are the best choice for long cycle life applications such as electric vehicles and energy storage systems."

Shown below is a scanning electron microscope (SEM) image of single crystal cathode material $\text{Li}[\text{Ni}_{0.6}\text{Mn}_{0.2}\text{Co}_{0.2}]\text{O}_2$ (NMC622) particles produced through NOVONIX's new patented dry processing methods.



SEM Image: Single Crystal Cathode material manufactured using NOVONIX's proprietary dry manufacturing process (DPMG), with potential to deliver lower-cost and lower-waste single crystal cathode material for high energy density, ultra-long lifetime lithium-ion batteries.

"These further results continue to show the value of continued development around our new technology to advance the battery materials space and our work towards lower cost, higher performance materials that the industry needs," Dr. Burns said.

Professor Mark Obrovac, lead inventor of the DPMG and new single crystal cathode materials and methods, said that his research targeted low-cost and scalable manufacturing techniques applied to high-performance, advanced battery materials.



"A major focus of my lab's research is the development of elegant dry processing methods for battery materials that are amenable to scaling, while simultaneously increasing yields, eliminating waste, and enabling the use of inexpensive feedstocks. Along the way we found out that these new methods can enable the synthesis of new advanced materials with properties that have not been previously accessible by more conventional methods. This has created a tremendous opportunity for the advancement of practical battery materials.

"I believe we have only tapped a fraction of these opportunities. It is my research plan to aggressively pursue the opportunities from these new methods while continuing to develop new dry processing methods that bring yet more opportunities to the table," Professor Obrovac said.

More details around the developed methods and materials will be published by Professor Obrovac and his team in the coming months. In the meantime, the team at NOVONIX BTS (a 100%-owned subsidiary of NOVONIX Limited) is working on installing pilot scale production capability for DPMG and Single Crystal Cathode manufacturing to support further development, scale-up and testing against state-of-the-art materials.

ABOUT DPMG

Through the research funded by NOVONIX BTS (NOVONIX's wholly owned subsidiary) in partnership with the Canadian government through the NSERC Industrial Research Chair program, Professor Obrovac and his team developed a breakthrough method that can be applied to the manufacturing of both anode and cathode materials for lithium-ion batteries called dry particle microgranulation (DPMG).

DPMG provides a method for synthesizing highly engineered particles through the consolidation of fine materials, that may otherwise be waste, into particles that can be tens of microns and suitable for use in lithium-ion batteries. The recent publication outlines methods of making spherical graphite for use in lithium-ion batteries with 100% yield where current methods have significant yield losses which increase the cost of manufacturing.

Patent applications protecting the DPMG process have been filed by NOVONIX under the commercialization arrangements with Prof. Obrovac and Dalhousie University with exclusive and royalty-free ownership by NOVONIX.

The DPMG technique has applications in creating both spherical graphite anode particles as well as cathode materials such as $\text{Li}[\text{NiMnCo}]\text{O}_2$ (NMC). The ability to make NMC and other cathode materials through dry mechanical processes has great potential to decrease waste and cost of current cathode manufacturing methods.

This announcement has been authorised for release by Phil St Baker, Managing Director, NOVONIX Limited.



ABOUT NOVONIX

NOVONIX LIMITED (ASX: NVX) is an integrated developer and supplier of high-performance materials, equipment and services for the global lithium-ion battery industry with operations in the USA and Canada and sales in more than 14 countries.

NOVONIX's mission is to support the global deployment of lithium-ion battery technologies for a cleaner energy future.

FURTHER INFORMATION

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