SUSTAINABLE SUPPLY CHAIN PROGRAM

CASE STUDY

# Study Shows Melanin has Potential as Alternative Battery Energy Storage Material in Lithium Batteries

River Road Research is an early stage technology development company with offices in Tonawanda, NY and Irwindale, CA. The company was incorporated in 2010 to invent, develop and market biotechnologies that support a sustainable economy with a focus on energy, food and water. Noco Energy has been the primary investor in River Road Research.

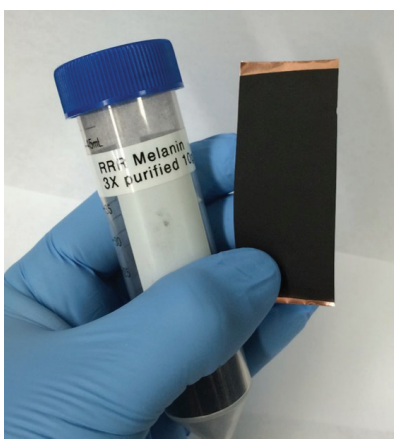
**Challenge**

River Road Research was recently awarded a patent for a method to produce melanin from food waste. Melanin is an organic polymer of quinone molecules, long known to have interesting physical and electrical properties but historically difficult to produce. Potential applications of melanin include: UV shielding, anti-oxidants, natural paints, and batteries.

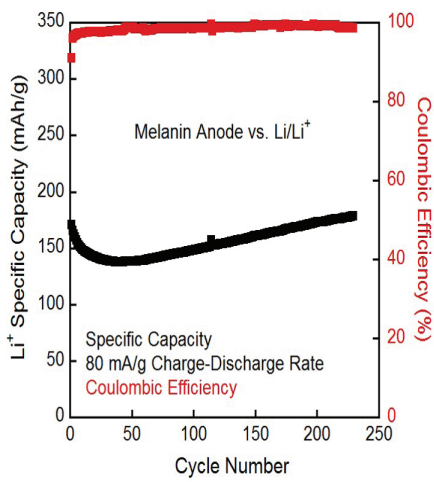
**Solution**

The market need for energy storage resources has been rapidly expanding in recent years. River Road Research recognized the potential melanin could have to impact this market and worked with New York State Pollution Prevention Institute (NYSP2I) and Rochester Institute of Technology's (RIT) Battery Prototype Center to evaluate the electrochemical performance of melanin in multiple battery designs, including capacity, rate capability, as well as battery lifecycle. The melanin slurry was provided by River Road Research and was produced from ordinary food waste, such as banana peels, spent brewer's grains, apple cores and other common household food waste items.

The study included four areas: fabricating and testing a melanin based anode as a lithium ion storage material versus conventional materials; fabricating and testing a lithiated melanin anode as an active lithium ion storage material; incorporating melanin into a mesocarbon microbead anode; and in the final test the melanin anode material was tested in a full cell design versus a conventional lithium-nickel-cobalt-aluminum oxide cathode design.




Example of Melanin & Coating




## CHALLENGE

- Produce melanin from food waste to address the need for energy storage resources

## SOLUTION

- NYSP2I worked with RIT's Battery Prototype Center to evaluate the electrochemical performance of melanin in multiple battery designs
- Four areas were studied to determine if a quinone polymer has a potential use for constructing organic batteries or as an additive in lithium batteries to promote longevity and/or dampen runaway reactions to promote safer lithium batteries

## RESULTS

- Melanin slurry was determined to be within the range of traditional anode materials
- Initial study demonstrated that melanin could perform within the range of anode materials used today and warrants further study as an alternative energy storage material
- Further improvement to the anode performance is expected with purification and modification of the melanin and composite optimization
- Common safety issues associated with lithium batteries can be avoided by using the melanin River Road Research provided from ordinary food waste

RIVER ROAD RESEARCH

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**Results**
The melanin slurry was determined to be within the range of traditional anode materials. The melanin-lithium mixture improved voltage and efficiency; however, the capacity was lower and would need to be improved to be a viable anode alternative. The melanin-mesocarbon mixture demonstrated a lower initial capacity and the rate performance was comparable to the control. The full cell had a low reversible capacity due to high first cycle loss of lithium and poor efficiency of melanin.

This initial study demonstrated that melanin could perform within the range of anode materials used today and warrants further study as an alternative energy storage material. Further improvement to the anode performance is expected with purification and modification of the melanin and composite optimization.

Common safety issues associated with lithium batteries can be avoided by using the recycled food waste material, melanin. "Conventional lithium batteries often utilize metal oxides and exotic carbon species in the electrode materials. This initial study shows great promise to replace these chemical compounds with melanin material produced from food waste using a sustainable manufacturing method," said Dr. Matt Ganter of the RIT Battery Prototyping Center. "If melanin can be used as an energy storage material in lithium batteries then you are introducing two significant environmental impacts: greener energy storage materials to support adoption of wind and solar technology and less carbon emissions from the mining, transportation and refining of metals."

River Road Research is currently looking for partners or funding to help with further development of this innovative battery technology.

## TESTIMONIAL

"Developing new battery materials is extremely challenging, especially for a small start-up working with organic materials. Dr. Ganter and Dr. Schauerman were patient and open minded in their approach. They used their considerable scientific experience, intellectual curiosity and old fashioned perseverance to help us advance our technology and show the viability of our organic polymer as a battery material."

– Scott Ernst P.E., Managing Director
River Road Research, Inc.

## NYSP2I PARTNERS

R·I·T Rensselaer
University at Buffalo The State University of New York
Clarkson University

New York Manufacturing Extension Partnership

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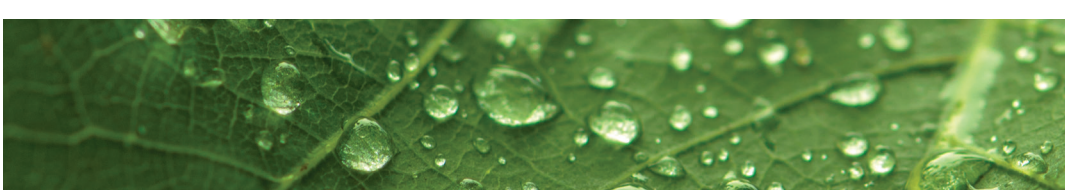

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