



## Highly Conductive Covalently Bonded Electrodes for Fast Charging Li-ion Batteries

### Background

To compete with the refuelling times of gas-powered vehicles and promote mass adoption of electric vehicles, a maximum of 15-minute charging time for Li-ion batteries is necessary as per the [U.S. Department of Energy](#). Current Li-ion battery technologies offer great longevity and power as well as adequate energy density for portable electronic and electric vehicles alike. However, they suffer from severe charge transport limitations at the anode causing lithium plating and dendrite formation that reduce their useful life and make them unsafe (fire hazard).

### Description of the invention

Traditional battery electrode architecture utilizes polymer binding of active particles with conductive additives. Waterloo researchers have developed a replacement architecture that utilizes covalent bonding to form a network of bound active particles. This architecture provides a method for increasing electronic conductivity as well as bonding strength (to the current collector) using functional covalent bonding of heterogeneous material including carbonaceous, metallic, and metalloid materials. The covalently joined electrode architecture is compatible with current materials and electrolytes, and it enhances their electrochemical performance compared to reference slurry architecture anodes.

### Advantages

The covalently joined architecture is about four times (4x) more electronically conductive than the traditional polymer-bonded architecture using the same materials. The increased conductivity reduces lithium plating by mitigating the potential gradient inside the electrode bulk with the associated additional benefit of lowering the potential fire hazard related to handling lithium materials. It also helps reduce Joule heating and thus enables a more energy efficient and less complex manufacturing process. The new architecture provides a more mechanically robust construction that helps prevent physical delamination from the current collector. Finally, the production of covalently joined architecture is compatible with the slot-die production line currently in operation with an extra sintering step that uses readily available equipment.

### Potential applications

- Fully electric vehicles
- Hybrid vehicles
- Auxiliary battery for gas-powered cars
- Electric airplanes
- Portable electronic (cell phones, cameras).
- Power tools

### Reference

WatCo 10196

### Inventor(s)

Dr. Yverick Pascal Rangom  
Dr. Michael Allan Pope

### Patent status

US Provisional patent #63/248,293  
filed on September 24<sup>th</sup> 2021

### Stage of development

Prototype

### Contact

Scott Inwood  
Director of Commercialization  
Waterloo Commercialization Office  
519-888-4567, ext. 33728  
[sinwood@uwaterloo.ca](mailto:sinwood@uwaterloo.ca)  
[uwaterloo.ca/research](http://uwaterloo.ca/research)