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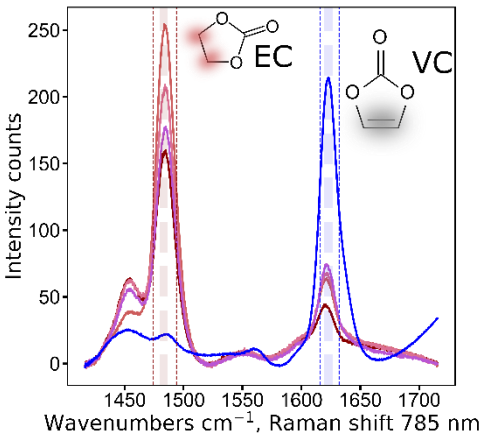
/ Where ideas thrive

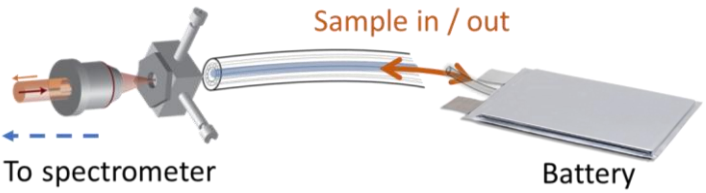
In-operando battery chemistry monitoring

A new optical methodology to study battery chemistry in working conditions using Raman spectroscopy

Case Ref: Gre-3747-19



Whilst the battery is in use, electrolyte is drawn out of the battery into the hollow-core optical fibre, and the battery chemistry is analysed using Raman spectroscopy.



The problem – Limitations in current battery monitoring technologies

Li-ion battery chemistry can currently only be monitored via a "quench and look" approach which is destructive to the battery. Electroimpedance spectroscopy is used to probe electrical characteristics, but does not yield chemical information. Typically, battery chemistry and lifecycle is complex. Therefore a detailed understanding of the degradation mechanisms that occur *in-operando* (whilst the battery is in use) is vital for next generation battery development.

The solution - An optical sensor capable of measuring battery chemistry *in-operando*

Professors Clare Grey and Jeremy Baumberg and their teams have invented a technique to bring Raman spectroscopy into the battery. Microlitre volumes (<25µl) of battery electrolyte can be sampled continuously and probed using Raman spectroscopy, using commercially available fibre optics *in-operando*.

Features

- High sensitivity (100 ppm) & small volume (<25µl)
- Electrolyte sampling and Raman measurement does not disrupt battery operation
- Electrolyte returned to battery after use
- Provides chemical info on each component

Benefits

- Can measure battery chemistry in situ
- Correlates chemical and electrical behaviour
- Routinely monitor and health-check lithium ion battery systems with minimal disruption
- Non-destructive, and does not perturb cell

Applications

Applications are likely to be in battery R&D and in monitoring of large-scale battery systems. Other applications could also be where continuous sampling, low sample volume and minimal perturbation to the system are needed.

Further information overleaf

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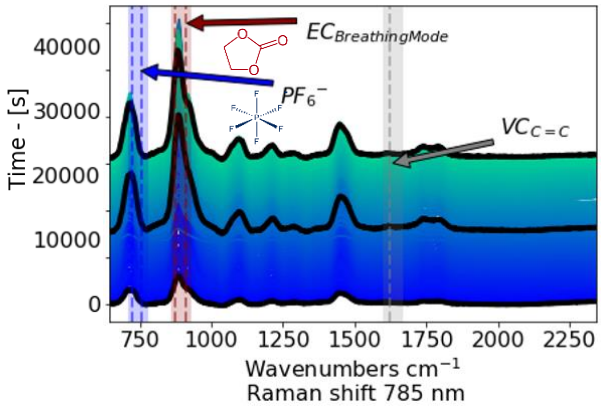
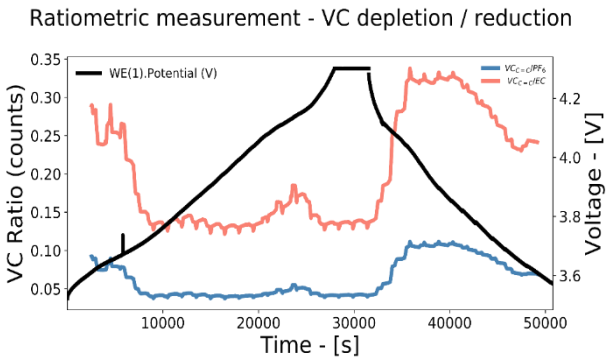
Figures 1 & 2. Data showing the change of vinylene carbonate relative concentration





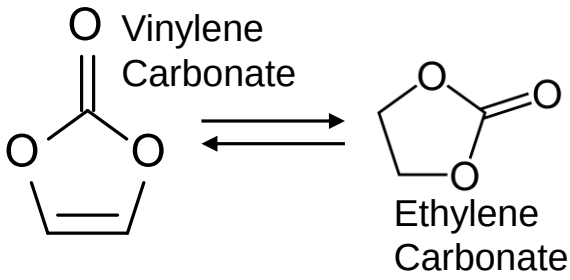
Stage of development

The academic team have shown that the technique is compatible with industrially relevant pouch cells. The team have demonstrated *in-situ* electrolyte sampling and Raman measurements of important additives from the pouch cells.

Implementation

The academic team has developed the equipment with a view to it being easily integrated into existing Raman spectroscopy equipment, found in laboratories worldwide. The system utilises commercially available high-end fibre optics, and the data generated can be exported for further analysis in commonly used data analysis software. We envisage that the biggest development challenge for the right industrial partner would be to productionise the connector that enables integration of this technique with existing Raman spectroscopy equipment.

Vinylene carbonate is an analyte of interest when monitoring battery lifecycle.



Using this technology has enabled *in-operando* monitoring of vinylene carbonate concentration.

The inventors

Professor Clare Grey FRS

Professor Grey's research focuses on using analytical techniques to probe the link between material structure and properties in disordered materials, with key focus on battery electrochemistry. Professor Grey's website lists her key publications and research interests.

Professor Jeremy Baumberg FRS

Professor Baumberg's research focuses on the practical use of nanophotonics, nanomaterials and optical characterisation techniques. Professor Baumberg's website lists his key publications and research interests

Commercialisation

This technology is protected by GB patent application GB1910757.2.

We are looking to partner with an instrumentation company to jointly develop and commercialise this technology. We expect this technology to be of particular interest to instrumentation companies who already have Raman equipment in their portfolio, or who already have distribution channels through to customers who would benefit from this technology. Development hurdles are not high and this technology could be applicable to a multitude of end users.