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EAG Laboratories

Analysis of Rechargeable Lithium-Ion Battery Electrolyte by GC-MS

The GC-MS method offers a simple, reliable, and accurate approach for analyzing the composition of lithium-ion battery electrolytes and ensuring quality control.

Currently, methods and literature on determining electrolyte composition are limited. The aim of this study is to develop a simple and efficient gas chromatography-mass spectrometry (GC-MS) detection method for the sensitive and rapid determination of the composition and content of lithium-ion battery electrolytes.

Introduction

The electrolyte in a lithium-ion battery serves as the medium that transports positive lithium ions between the cathode and anode. It is typically composed of lithium salts dissolved in organic solvents. To allow the free movement of lithium ions, the electrolyte solution must have a high dielectric constant and low viscosity. As a result, effective electrolyte solutions are usually a blend of cyclic and linear carbonate esters, with the precise composition being crucial for the battery's overall performance.

Experimental

A rechargeable lithium-ion battery was disassembled in an argon glove box. The electrolyte was extracted from the jelly roll with dichloromethane. The sample was transferred to a 2 mL GC vial. Analysis of the extracted electrolyte solution was conducted on an Agilent 88909 Gas Chromatograph/ Agilent 5977C Mass Spectrometer.

GC Column:	30 m X 0.25 mm DB-5MS UI (J&W Scientific) 0.25 µm film thickness
Column Flow rate:	1.2 ml/min, constant flow mode
Detector:	Mass Selective Detector (MSD)
Injection temperature:	320 ºC
Injection Mode:	Split injection (10:1 split ratio)
GC oven temperature:	1) 35 ºC (hold 5 min) 2) 20 ºC/min to 300 ºC (hold 10 min)

An instrument blank was measured by running the GCMS cycle with a DCM solvent (i.e., no “injection”) prior to running any samples.

All ppb values were calculated as ng of compound/g of sample.

Results and Discussion

Figure 1 shows the results of analysis of the lithium-ion rechargeable battery electrolyte solution. Each component was identified by the mass spectrum using the existing compond library which are shown in Figure 2. The dimethyl carbonate (DMC), ethyl methyl carbonate (EMC), and propylene carbonate (PC) used as the solvent were identified from a mass spectral library search. In addition, vinylene carbonate and ethyl phosphine derivative used for the additives were also identified.

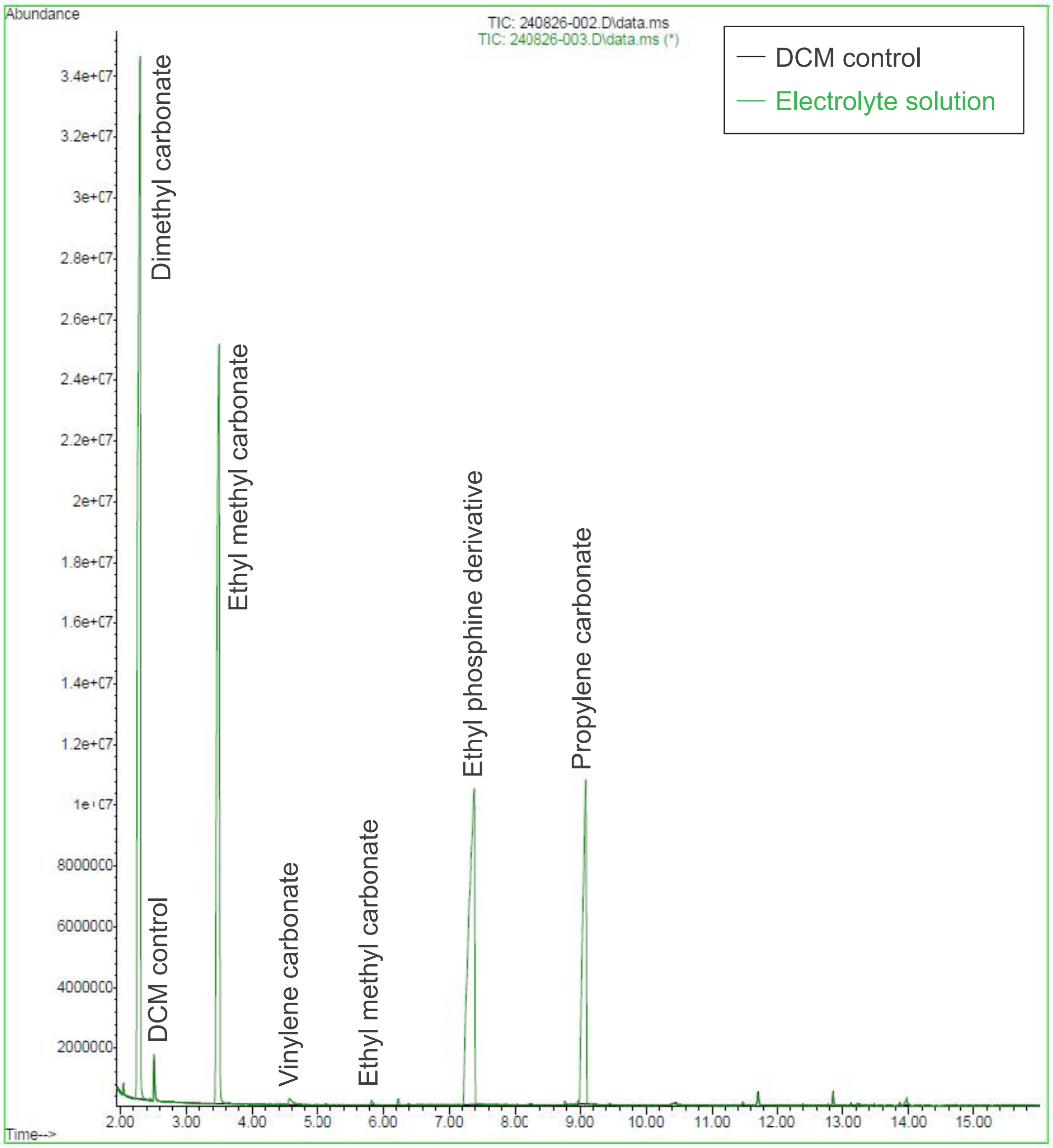

Figure 1: Total ion chromatogram of a diluted electrolyte sample

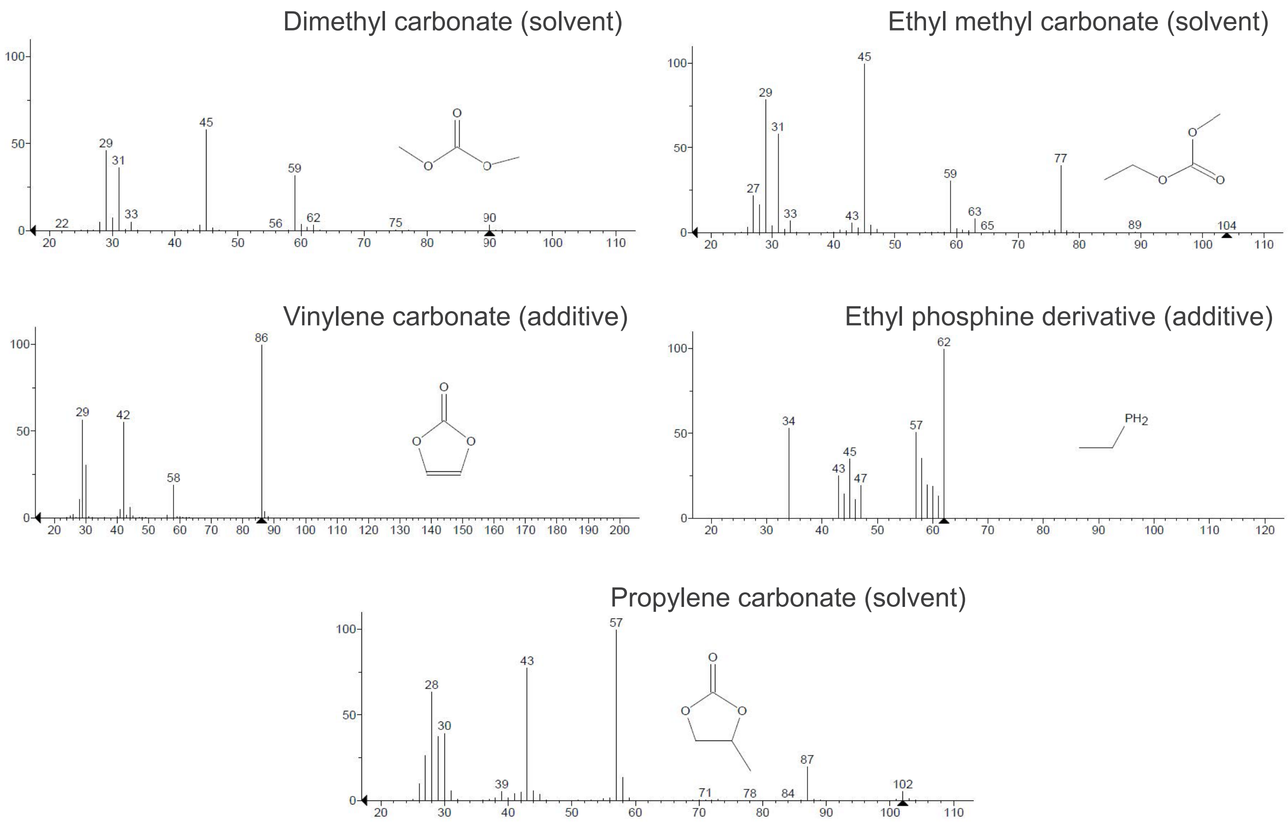

Figure 2: Mass spectra of target compounds

Conclusion

The GC-MS method offers a simple, reliable, and accurate approach for analyzing the composition of lithium-ion battery electrolytes and ensuring quality control. The samples can be easily diluted with an appropriate solvent and directly introduced into the GC-MS system.

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