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Application Data Sheet

No. 7

GC
Gas Chromatograph

Simultaneous Analysis of Evolved Gas Produced by the Degradation of a Lithium-Ion Battery

In evaluating the degradation of lithium-ion rechargeable batteries, it is necessary to analyze the gases produced inside the battery. The composition of the sampled internal gases can be investigated by conveying them to a gas chromatograph. The Shimadzu Tracera High-Sensitivity Gas Chromatograph uses a revolutionary plasma technology to detect all compounds except He and Ne. The system is capable of the simultaneous analysis of C1 to C3 hydrocarbons and inorganic gases including hydrogen, so it eliminates the conventional need for carrier gas switching or combined use of multiple systems. In addition, the Tracera's high sensitivity makes it possible to analyze small quantity gas samples.

This Data Sheet introduces the simultaneous analysis of internal gases from a lithium-ion rechargeable battery utilizing the Tracera system.

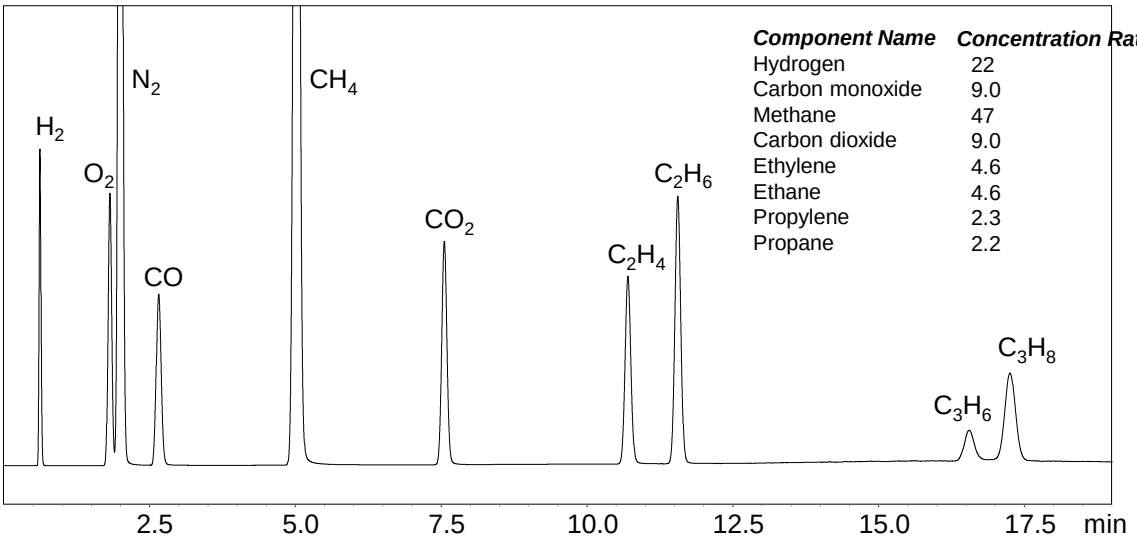
Instruments Used and Analysis Conditions

Instruments Used	
Software	GCsolution
Gas chromatograph	Tracera（GC-2010 Plus A + BID-2010 Plus）
Analysis Conditions	
Column	Micropacked ST
Column temperature	35℃(2.5min) - 20℃/min - 250℃(0min) - 15℃/min - 270℃(5.42min) Total.20min
Carrier gas controller	Pressure
Pressure program	250kPa(2.5min) – 15kPa/min – 400kPa(7.5min) (He)
Injection mode	Split (1:10)
Injection port temperature	150℃
Detector temperature	280℃
Discharge gas volume	70mL/min
Injection volume	50µL

Results

Analysis of Internal Gases from a Lithium-Ion Rechargeable Battery

Fig. 1 shows the chromatogram for the internal gases from a lithium-ion rechargeable battery. It is evident that the system is capable of the simultaneous analysis of C1 to C3 hydrocarbons and inorganic gases including hydrogen. The concentration ratios (%) for each component excluding oxygen and nitrogen are shown.



Component Name	*Concentration Ratio (%)*
Hydrogen	22
Carbon monoxide	9.0
Methane	47
Carbon dioxide	9.0
Ethylene	4.6
Ethane	4.6
Propylene	2.3
Propane	2.2

Fig. 1: Chromatogram for the Internal Gases from a Lithium-Ion Rechargeable Battery

Note: With baseline calibration

Linearity for each component of the standard gas was confirmed. The concentration values for each component are shown in Table 1, and the chromatograms and calibration curves for each component are shown in Fig. 2.

Table 1: Concentrations for Each Component

Component name	*Concentration (%)*			
Hydrogen	0.962	1.92	2.89	4.81
Carbon monoxide	0.404	0.808	1.21	2.02
Methane	2.08	4.16	6.24	10.4
Carbon dioxide	0.412	0.824	1.24	2.06
Ethylene	0.204	0.408	0.612	1.02
Ethane	0.204	0.408	0.612	1.02
Propylene	0.102	0.205	0.307	0.512
Propane	0.101	0.202	0.303	0.505

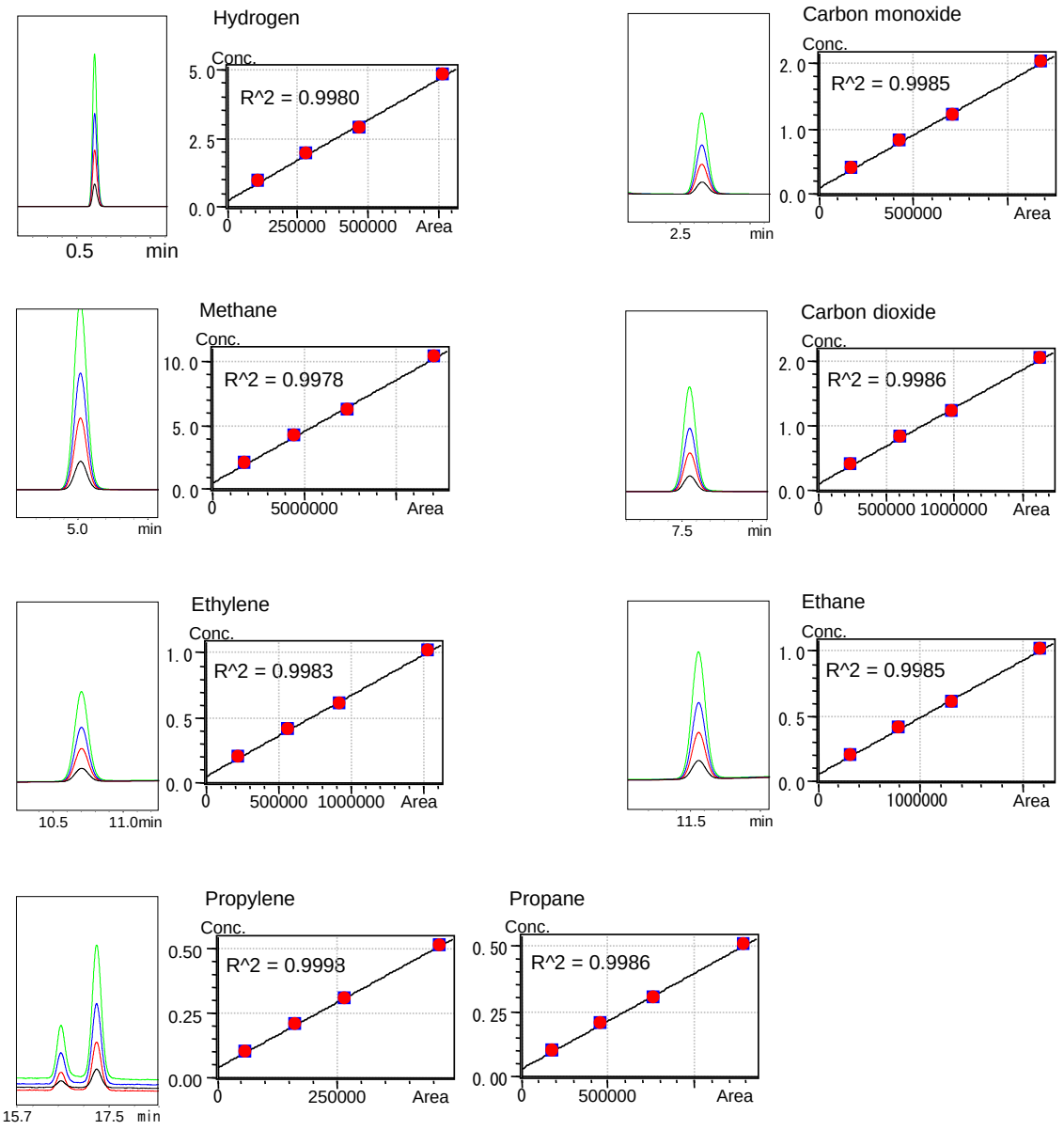


Fig. 2: Linearity for Each Component

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