Various kinds of *in-situ* measurements of Lithium ion battery materials

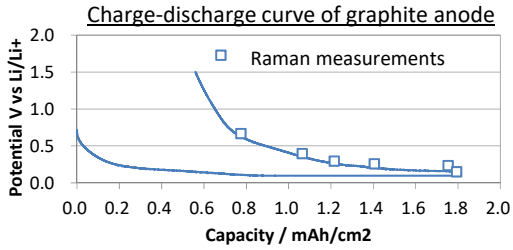
TRC can provide various kinds of *in-situ* measurements of lithium ion battery. Here, some examples of *in-situ* applications are shown, such as, charge-discharge in situ Raman measurement, and temperature dependence of diffusion coefficients estimated by PFG-NMR

In-situ measurements and its applicability

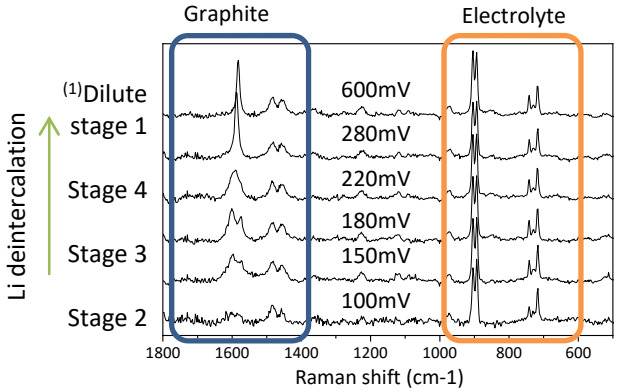
Electrochemical *in situ* measurements	Instrumental analysis	features
Structural change of active materials (Single particle analysis of composite electrode)	*In-situ* TEM observation (Single particle)	0.2nm～
	In-situ Raman	1μm～
Charge-discharge in-situ measurement, Reaction distribution in the single layered laminated cell	*In-situ* XRD (single layered laminated cell)	1mm～
Analysis of product level LIB	Synchrotron, neutron diffraction	1mm～

Temperature dependent measurements	Instrumental analysis	features
Diffusion coefficient measurements	PFG-NMR	-40～150℃
Reaction mechanism of Solid State electrolyte (Crystallization, gas generation, composition)	Raman	～350℃
	XRD	～1000℃
	TPD-MS	～550℃
Chemical and crystallographic change of active materials	Temperature dependent *in situ* TEM	～1300℃
	Raman	～500℃
	XRD	～1000℃
Safety tests	Gas analysis, X-ray CT observation	

Characterization of graphite by *in situ* Raman



Active material : Graphite/SiO, counter electrode : Metal Li
Electrolyte : 1M $LiPF_6$ EC:DEC=1:1(vol)
CCCV discharge to 100 mV, CC charge until 600 mV (0.05C)



(1)Inaba, et al., J. Electrochem. Soc.,142, 20 (1995)

Diffusion coefficient measurements by PFG-NMR

- Temperature range : -40～150℃
- Measurement nucleus : ^{1}H, ^{7}Li, ^{19}F, ^{31}P, ^{23}Na

(First introduction in Japan as instrumental analysis company, March 2019)

→ Available for the heating / cooling cycle of JIS standard (-40～85℃)