Advanced spectroscopies to study Li-ion batteries

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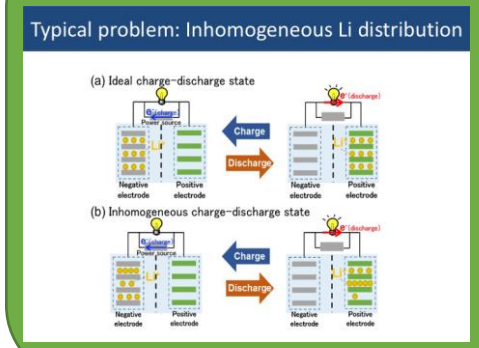
Objective: To determine the state of charge (SoC) and state of health (SoH) of Li-ion batteries with positron annihilation spectroscopies.

Overview

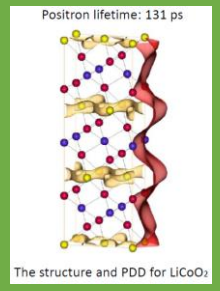
Typical problem: Inhomogeneous Li distribution

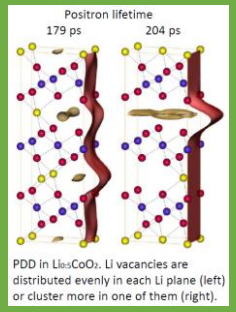


Approaches:

- Positron lifetime spectroscopy
- Coincidence Doppler Broadening

PALS

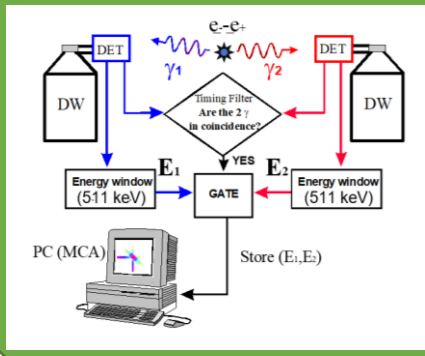




Positron density distribution (PDD) in Li_xCoO_2 samples

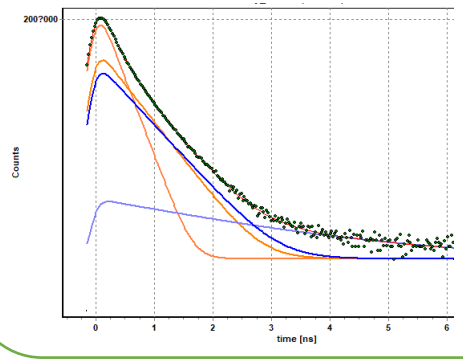
Ref. B. Barbiellini et al. Journal of Physics: Conf. Series 791 (2017) 012016

Doppler broadening

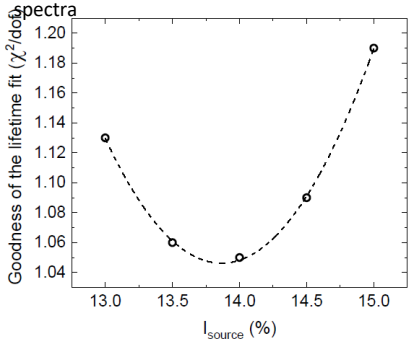


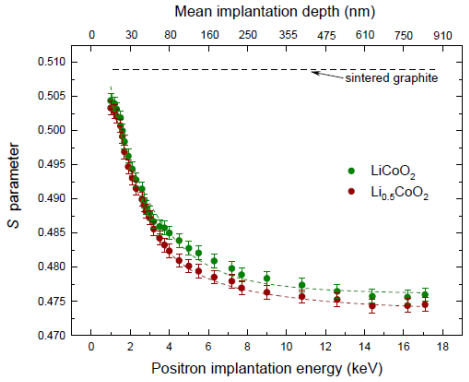
To study the microstructure and defects associated with the cathode oxides using a variable energy positron beam (from 1 to 17 keV).

Results



Optimizing the goodness of fit to obtain the Kapton/source contribution to the PALS spectra





Positron lifetime components and intensities

Cathode	Thickness (μm)	τ_1 (ps)	τ_2 (ps)	I_1 (%)	I_2 (%)	τ_{av} (ps)
$LiCoO_2$	59 (2)	163 (2)	315 (3)	66 (2)	34 (2)	215 (4)
$Li_{0.5}CoO_2$	67 (2)	181 (2)	327 (3)	73 (2)	27 (2)	220 (4)

Positron diffusion length and S parameters

Cathode	L_+ (nm)	$S_{surface}$	S_{bulk}
$LiCoO_2$	60 (3)	0.506 (1)	0.4760 (7)
$Li_{0.5}CoO_2$	55 (3)	0.505 (1)	0.4742 (7)

Summary: Positron annihilation characteristics (i.e., lifetime and Doppler broadening) are sensitive to both SoC (Li concentration) and SoH (defects).