Temperature Evolution of Evaporative Li Coatings in LTX-β

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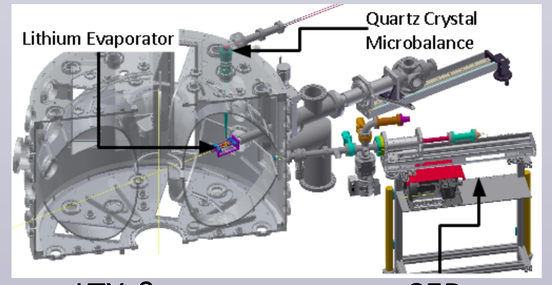
Goals

- Examine LTX-β sample after extended exposure to residual vacuum and partial vents
- Characterize temperature dependence of oxidation mechanisms in evaporative Li coatings

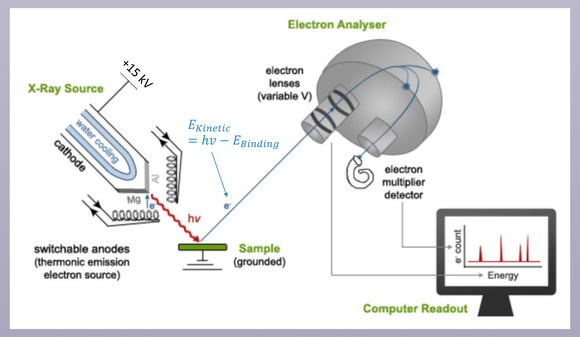
Sample Exposure Probe and LTX-β

- The Lithium Tokamak eXperiment (LTX-β) has evaporative Li coatings, covering most of the walls
- The Sample Exposure Probe (SEP) interfaces directly between LTX-β and the PHI 5300 ESCA surface analysis chamber in the Surface Science and Technology Laboratory (SSTL)
- The SEP was equipped with a button heater and PID controller for temperature studies of Li films, analyzed by X-ray Photoelectron Spectroscopy (XPS)



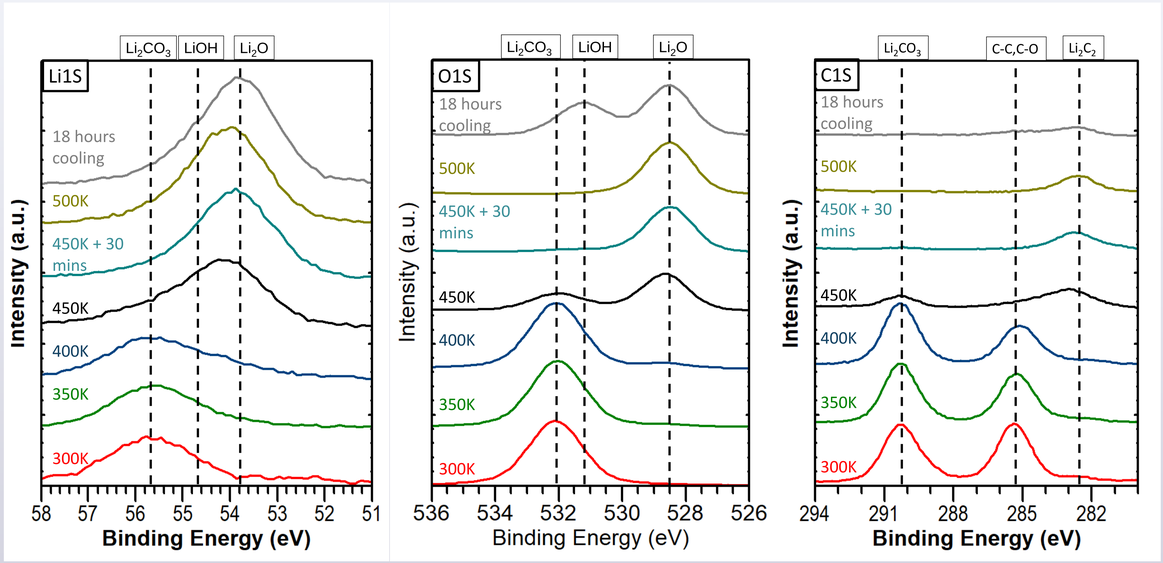
LTX-β SEP

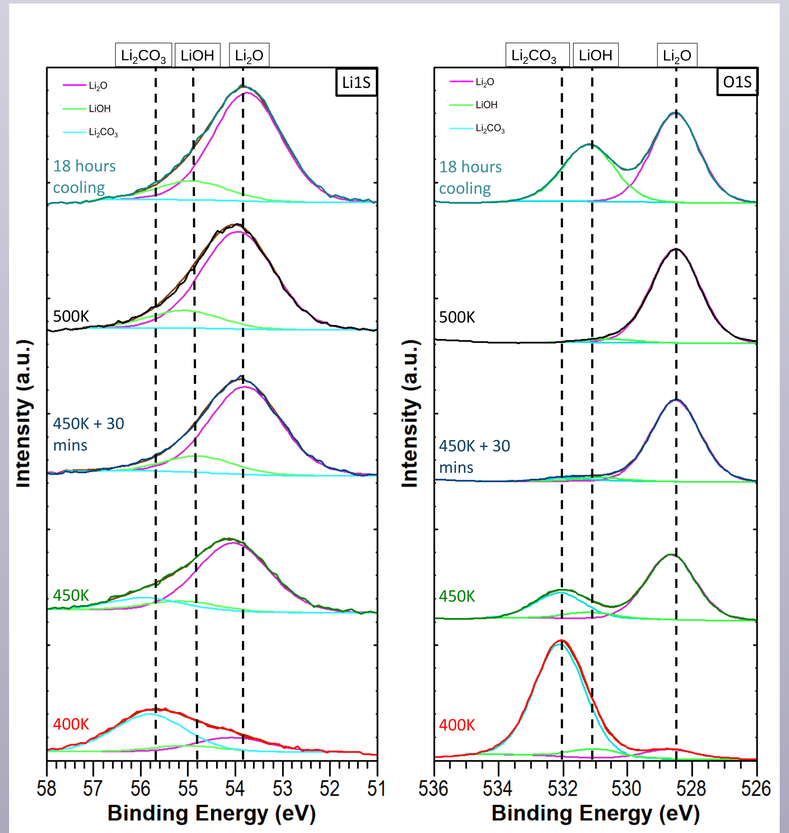
- SEP transfer pressure of approximately 3.5×10^{-9} torr
- XPS was taken using a Mg filament at 15kV and 300 W at a base pressure of $\mathbf{7.5 \times 10^{-9}}$ torr and temperatures ranging from 300-500K



http://faculty.chem.queensu.ca/people/faculty/horton/research.html

Sample Heating and Analysis by XPS



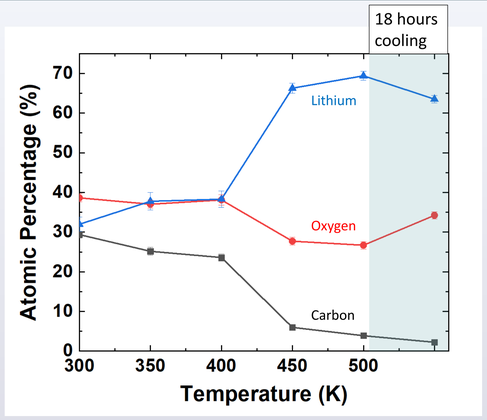


Experiment

- Baseline XPS spectra was taken at 300K and then heated in 50K steps
- Two points were taken at 450K as the surface composition changed during data acquisition
- The sample then cooled overnight and an additional spectra was taken at 300K to measure the stability of new surface compounds
- XPS spectra were then compared to values found by Wood et al. for Li compounds [1-2]

Results

- Initial XPS spectra of the aged LTX-β sample indicate a strong presence of Li_2CO_3
- Decomposition of Li_2CO_3 begins at 400K
- Reaction rate increases at 450K, quickly converting all Li_2CO_3 to Li_2O
- Heating to 500K eliminates most all surface contaminants other than Li_2O which has been shown to retain H with similar efficiency as Li [3]
- Li_2O reacts with residual water vapor overnight to form LiOH



Heating the sample from 300 - 500 K results in:
- Atomic percent of C reduced from 29.4% to 3.9%
- Atomic percent of Li increases from 32.0% to 69.4%

Conclusions

- LTX-β evaporative Li coatings form Li_2CO_3 over time with partial vents
- Li_2CO_3 converts to Li_2O when heated to 450K at 7.5×10^{-9} torr
- New surface conditioning technique option for LTX-β for extended time between plasmas
- Future work can examine fresh LTX-β Li samples as well as dosing Li at various temperatures

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[2] A.C. Kozen, *The Journal of Physical Chemistry C 2014 118 (48), 27749-27753*
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