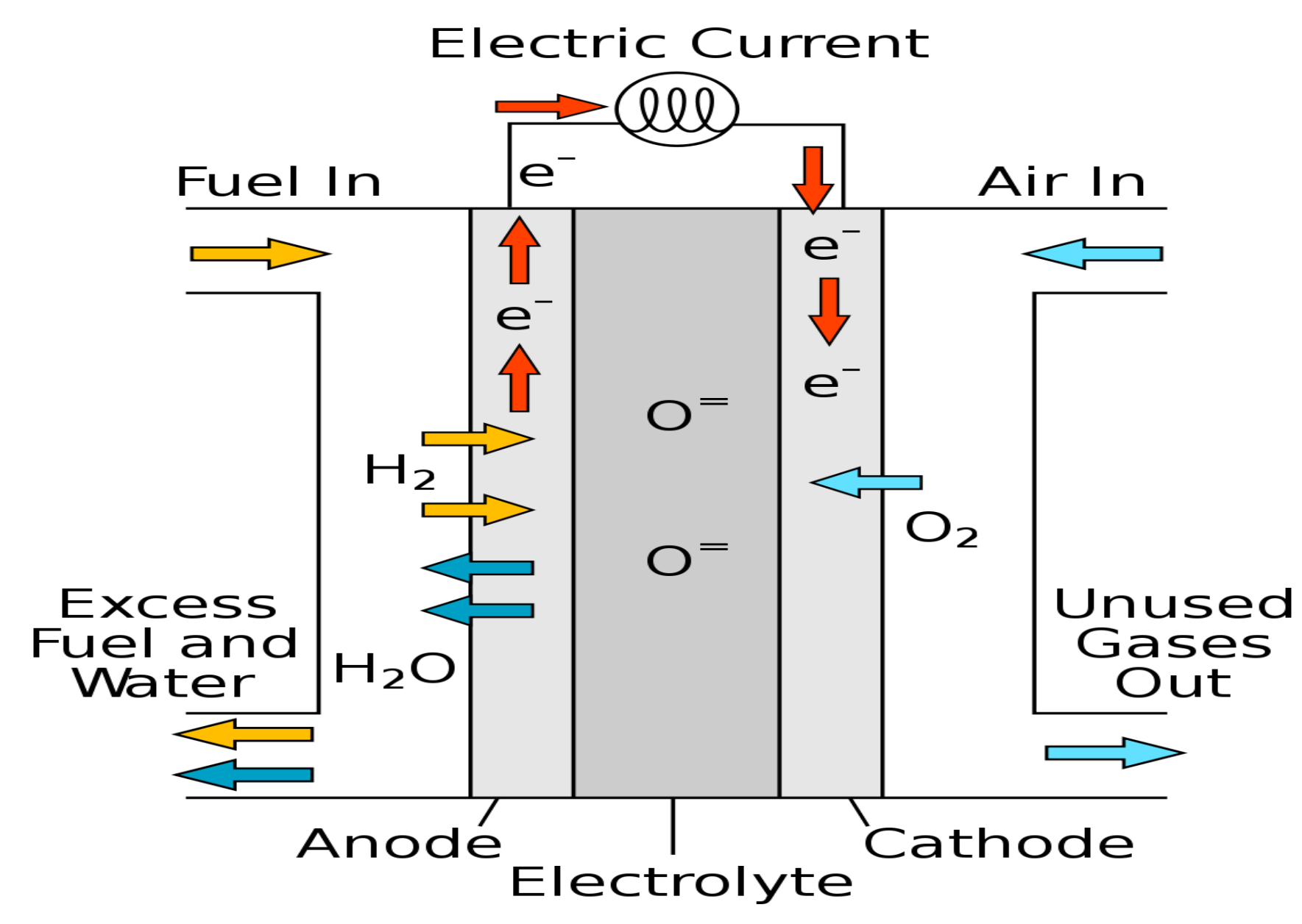
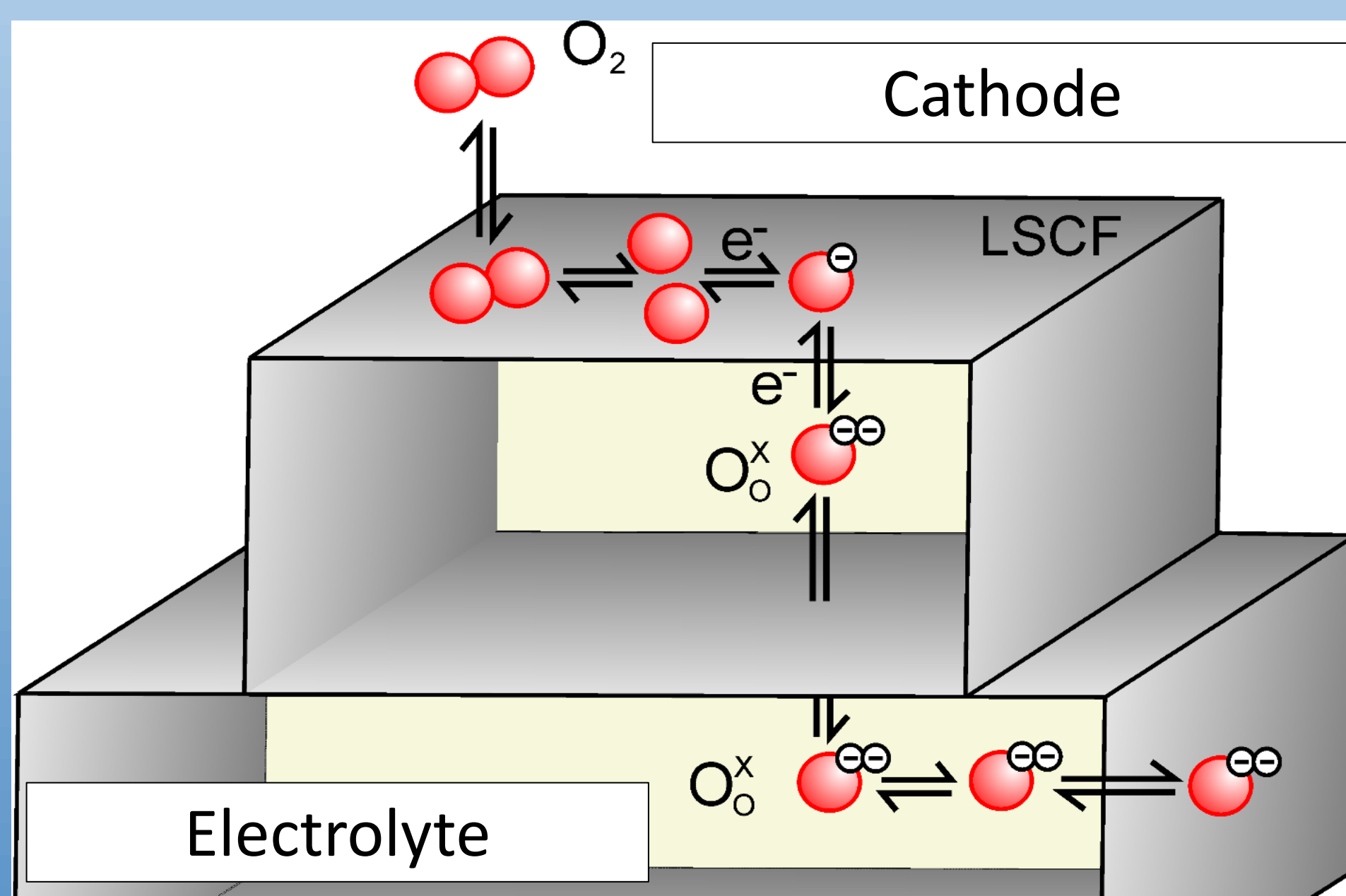


## Solid Oxide Fuel Cells (SOFC)

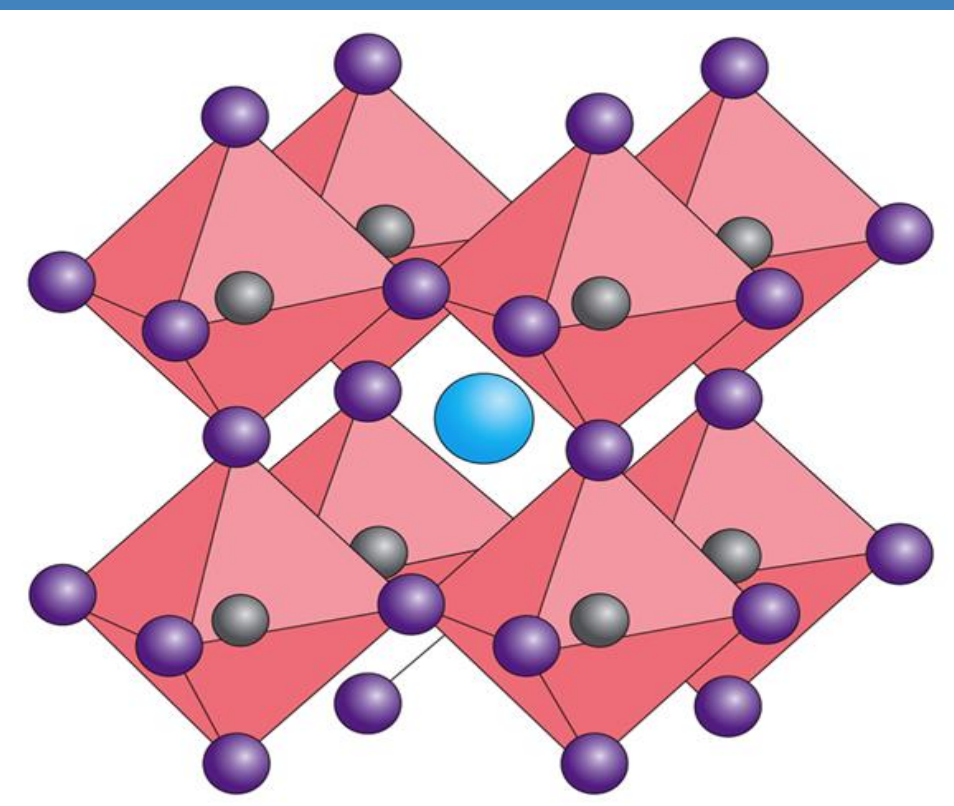


Cathode has the slowest kinetics!  
 How to speed up surface reactions (ORR)?

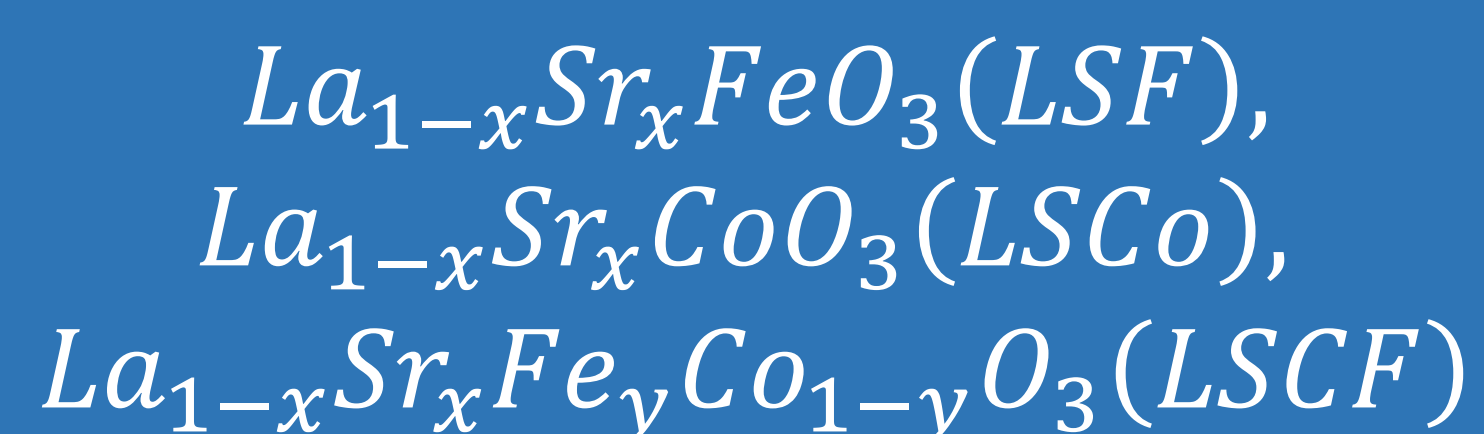
## ORR mechanism



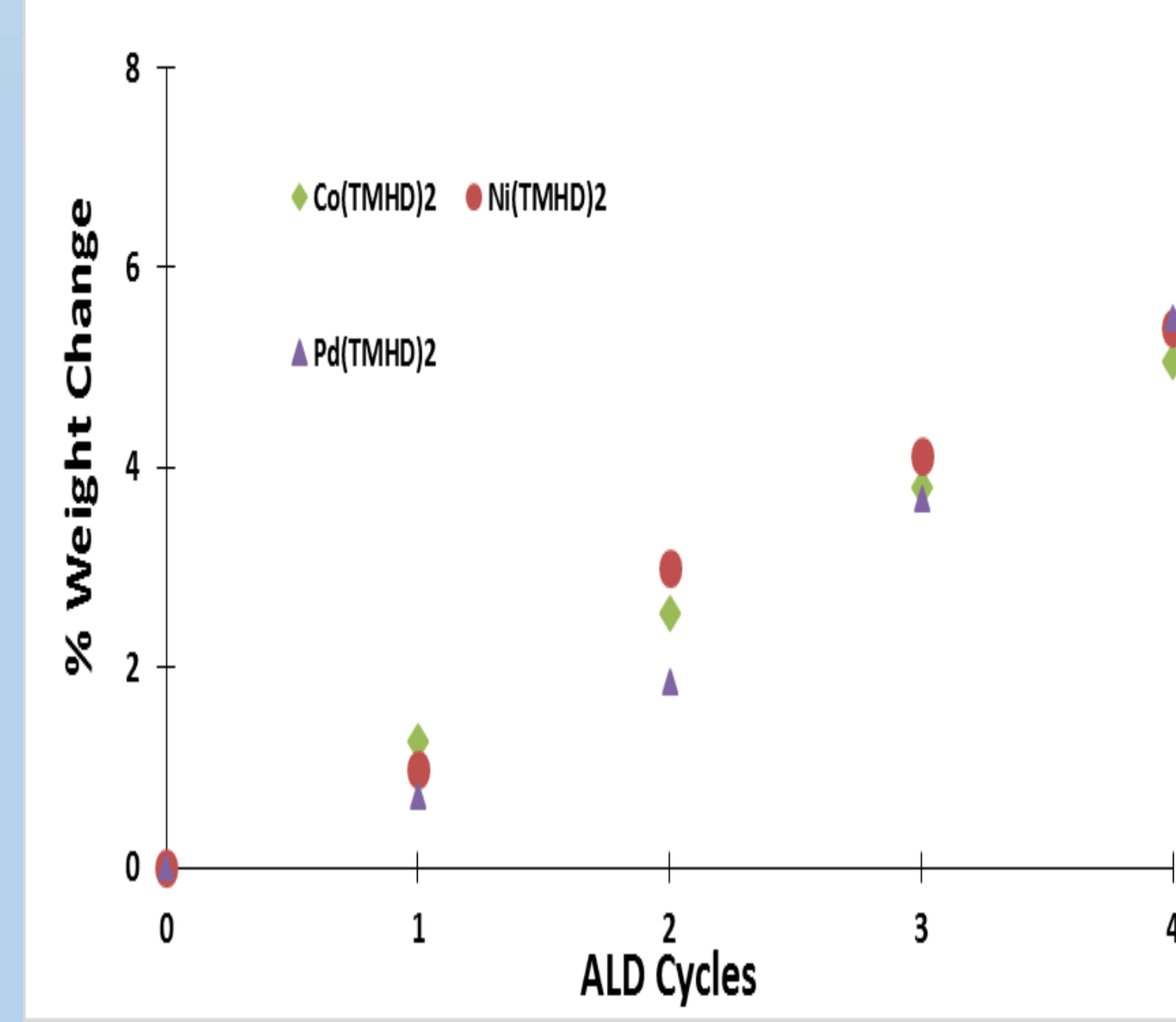
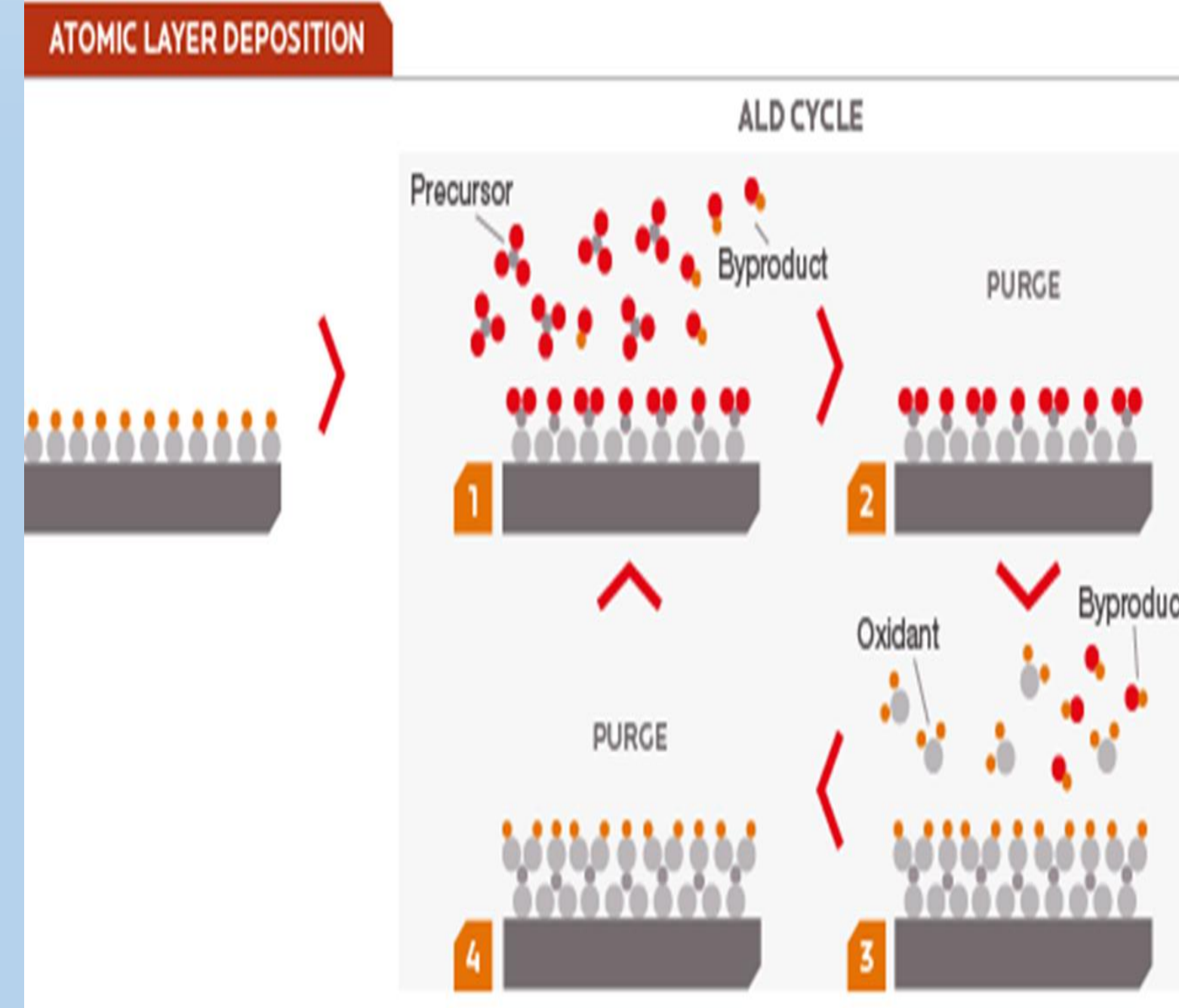
## Cathode Materials: Perovskites (ABO<sub>3</sub>)



- MIECs
- ORR active, but slow



## Atomic Layer Deposition (ALD)

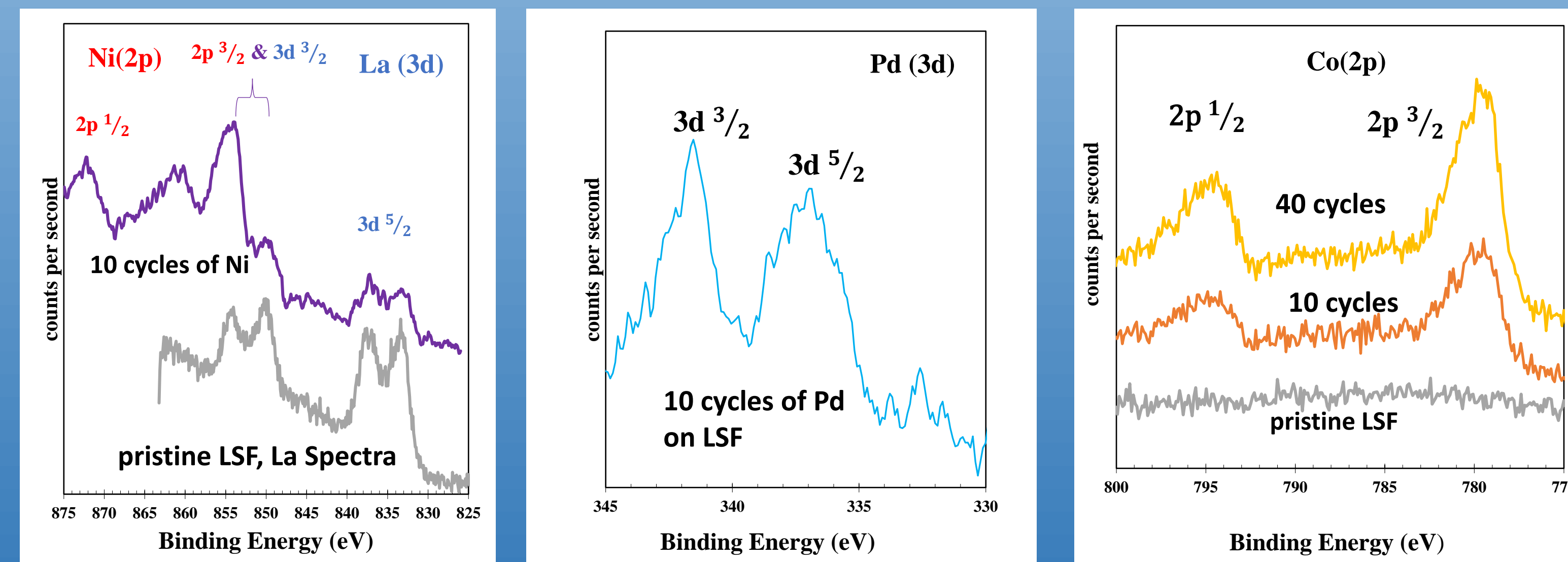


Material	Film Thickness/cycle (nm)
PdO	$\sim 1.4 \times 10^{-2}$
NiO	$\sim 1.7 \times 10^{-2}$
Co <sub>3</sub> O <sub>4</sub>	$\sim 1.7 \times 10^{-2}$

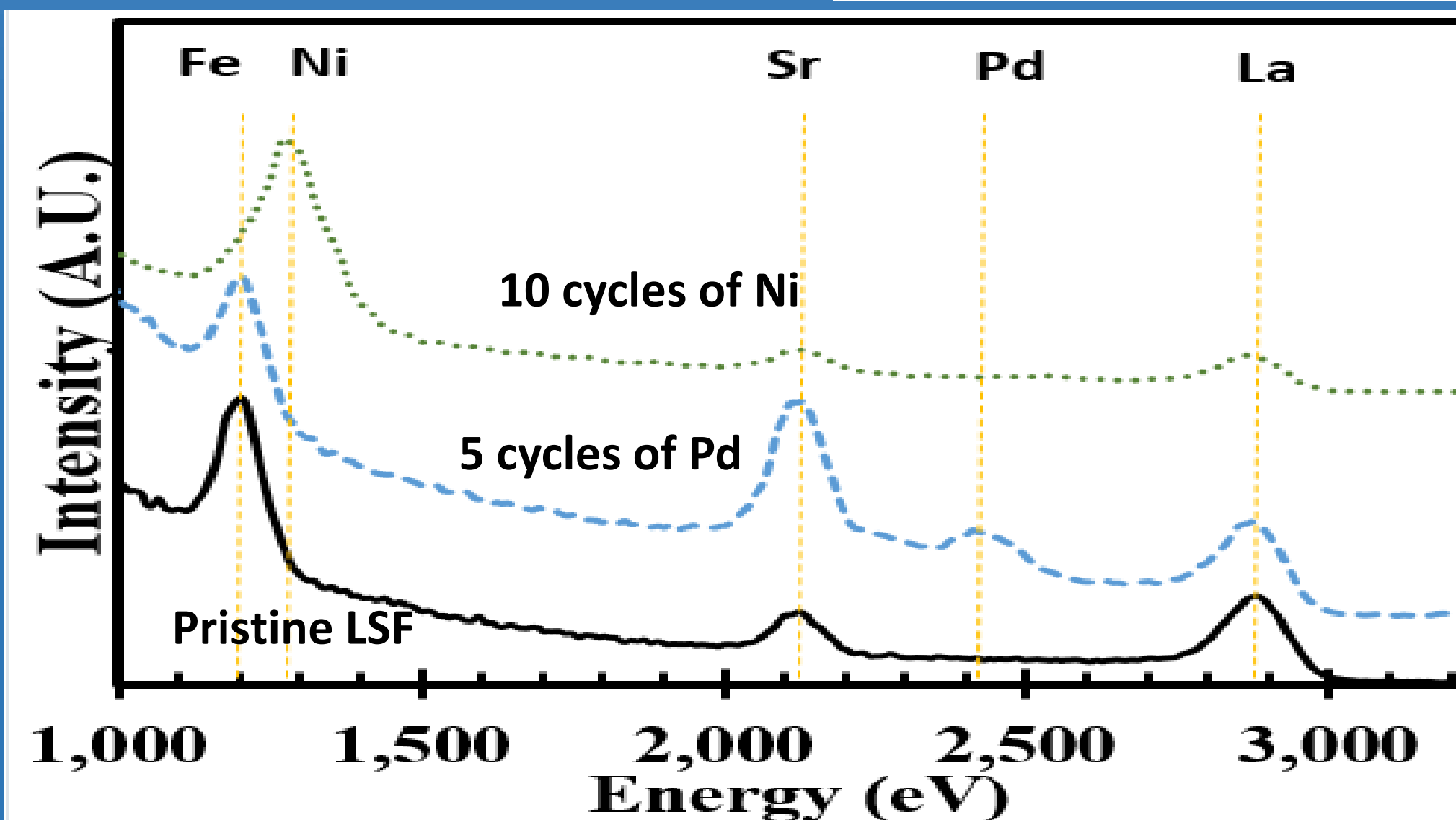
### ALD:

- Modify surface chemistry without changing the morphology
- Deposit thin films with controlled thicknesses
- Self-limited deposition process

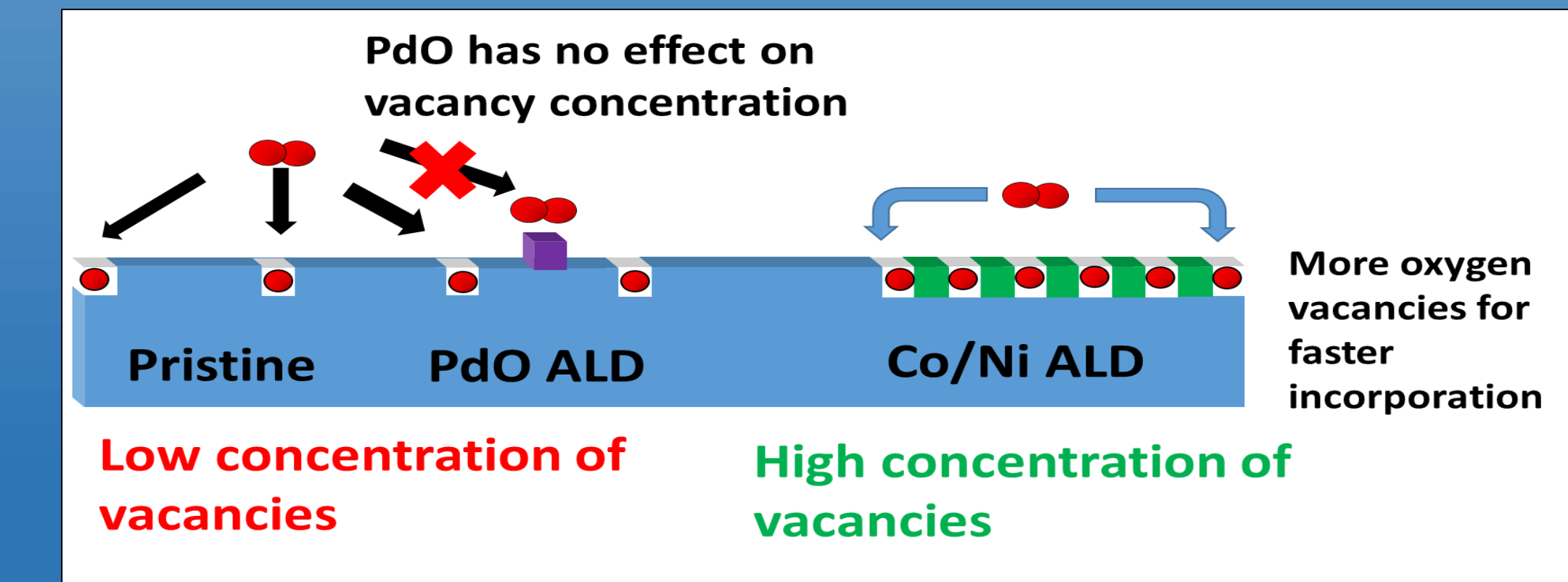
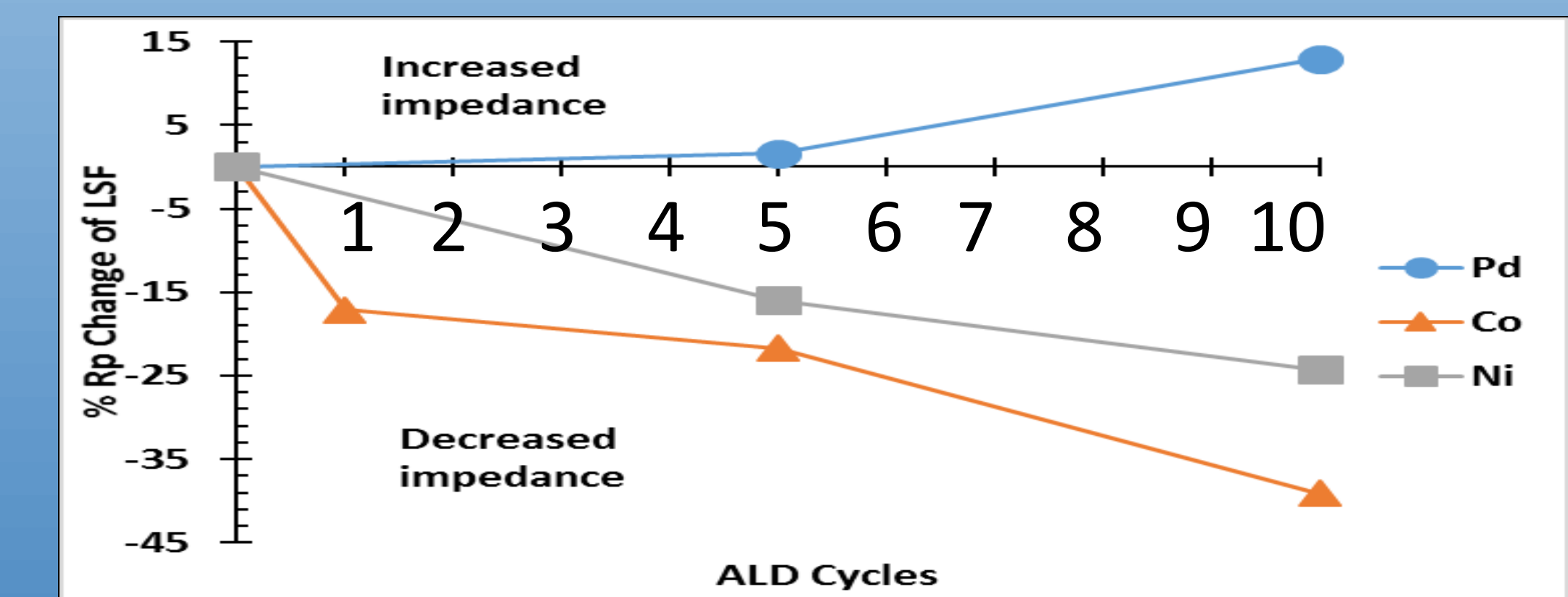
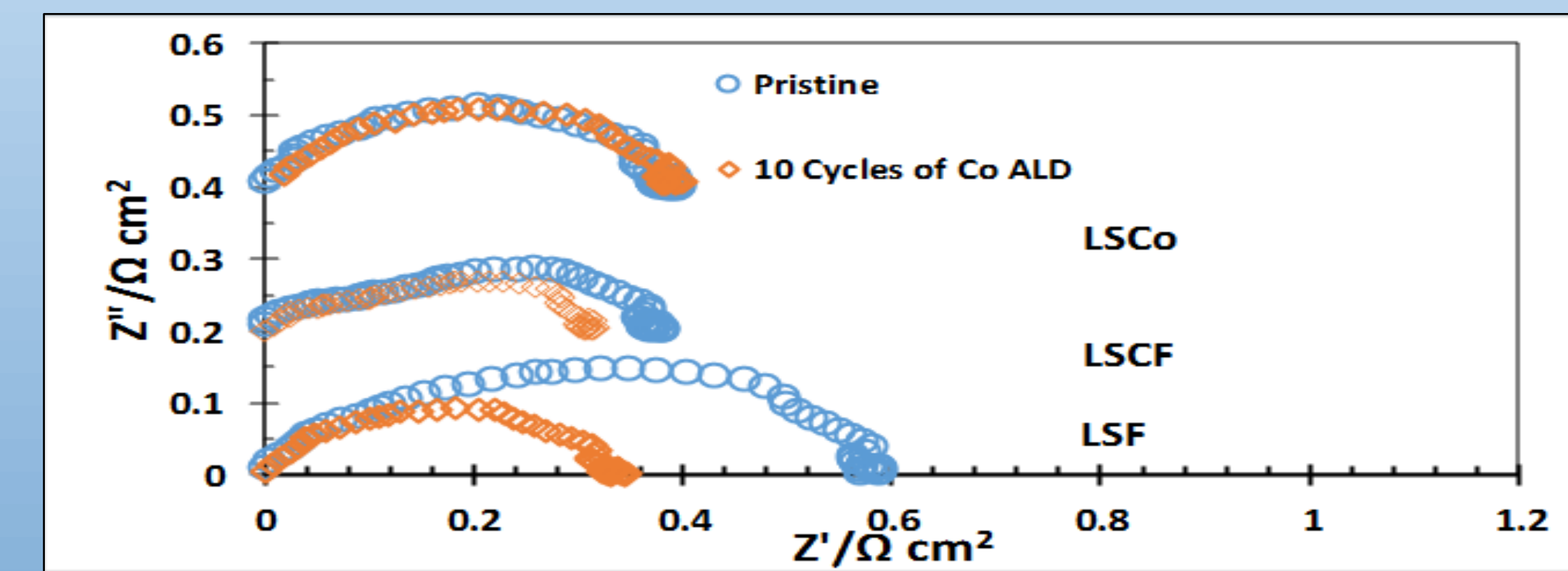
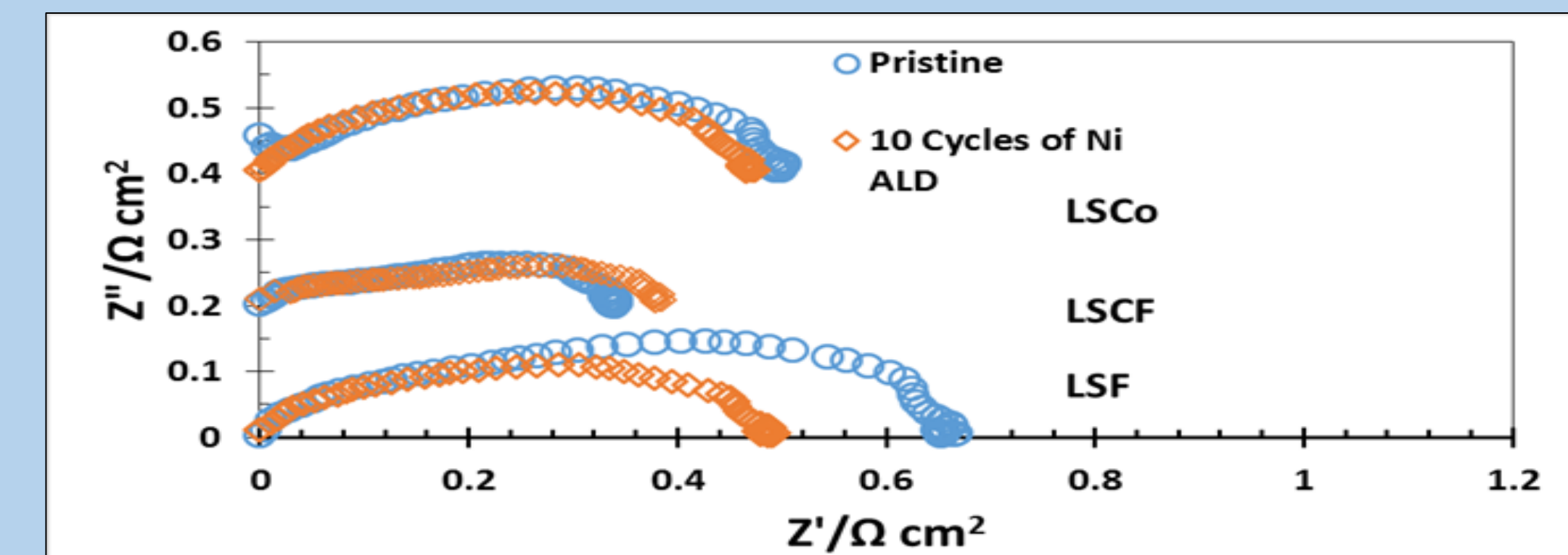
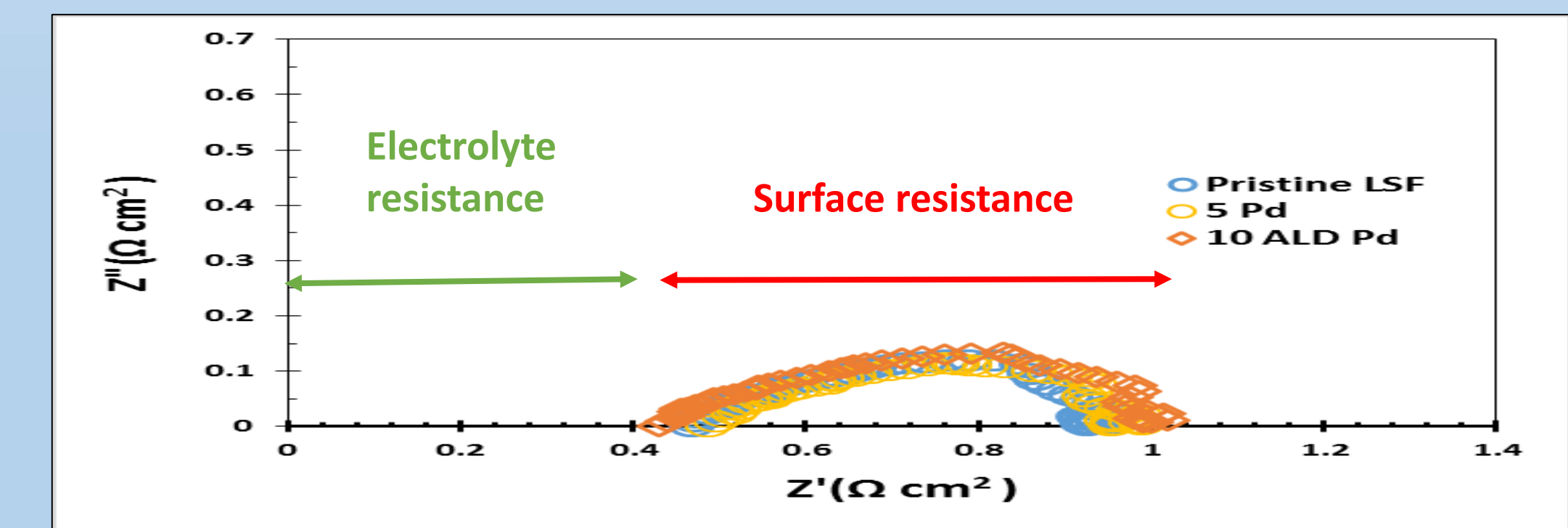
## Surface Characterization (XPS & LEIS)



- ### LEIS:
- Measures difference in momentum after ion collisions
  - Only sensitive to a few angstroms



## Electrochemical Impedance Spectroscopy



### Acknowledgements



### References

- Winterfeld, S. A solid oxide cells (SOFC&SOEC) electrode and cell level modeling [http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-8769/15106\\_read-13659/](http://www.dlr.de/tt/en/desktopdefault.aspx/tabid-8769/15106_read-13659/) (accessed May 15, 2018).
- Atomic Layer Deposition. (n.d.). Retrieved from <http://www.asm.com/technology/key-technologies/atomic-layer-deposition>
- Rahmani-pour, M.; Cheng, Y.; Onn, T. M.; Donazzi, A.; Vohs, J. M.; Gorte, R. J. *Journal of The Electrochem Society* (2017), 164 (7).