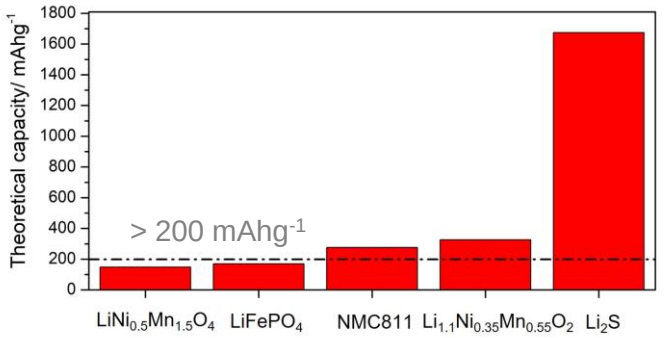
Cathode materials for next-generation high-energy density battery cells

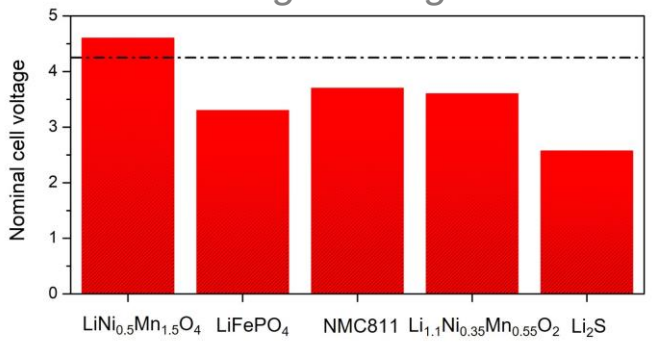
Battery component	Battery Technology			
	GEN3a	GEN3b	GEN4	GEN5
Cathode	Li, Co, Ni, Mn, Al	Li, Ni, Mn, Al	Li, Ni, Mn, Al	C, S
Anode	C	C + Si	C + Si or Li	Li
Electrolyte	Liquid electrolyte		Solid electrolyte	
Energy density	++	+++	++++	++++
Sustainability	++	+++	++++	++++
Forecast	Current	2025	2025-2030	>2030
	Max: ++++			

Next-generation cathodes

High-capacity

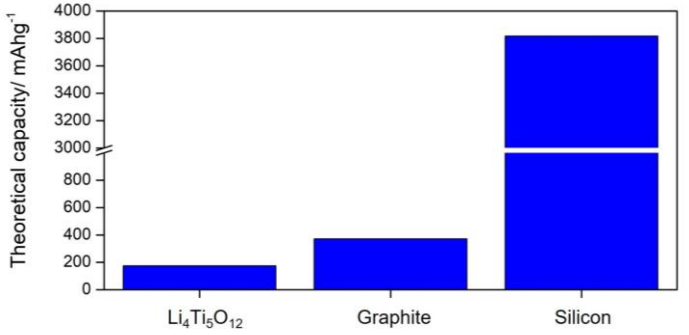


High-voltage



Next-generation Anodes

High-capacity

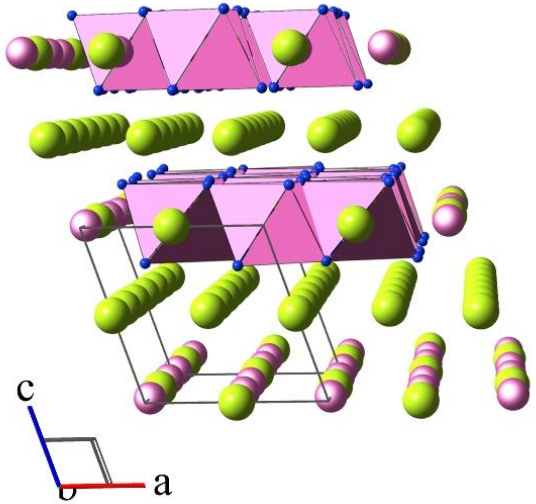


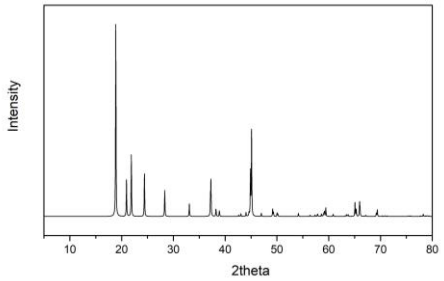
The COBRA project aims to develop Co-free generation 3b batteries using Li-rich oxide and Silicon composite as electrodes

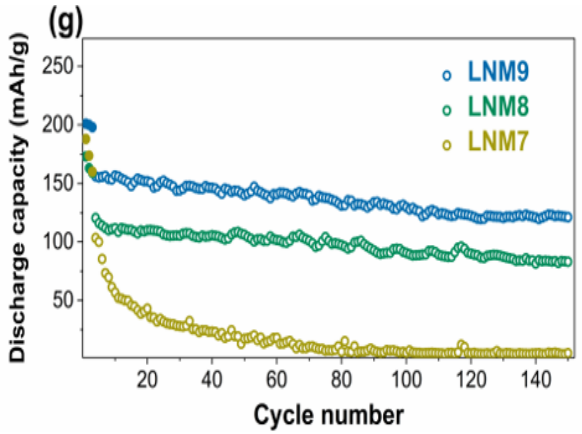
Energies: doi.org/10.3390/en14144223

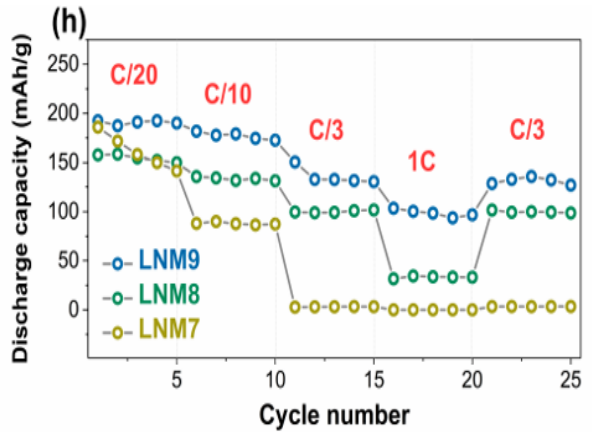
Co-free $Li_{1.1}Ni_{0.35}Mn_{0.55}O_2$

Temperature-driven chemical segregation in Co-free Li-rich-layered oxides and its influence on electrochemical performance

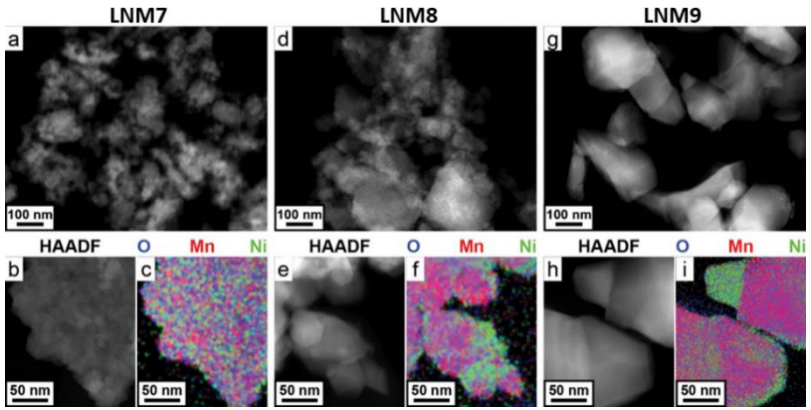


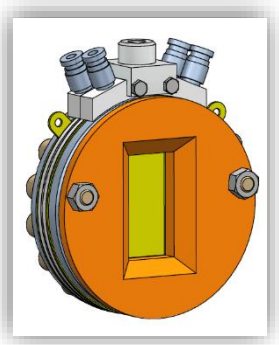


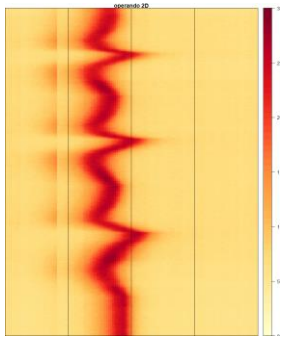




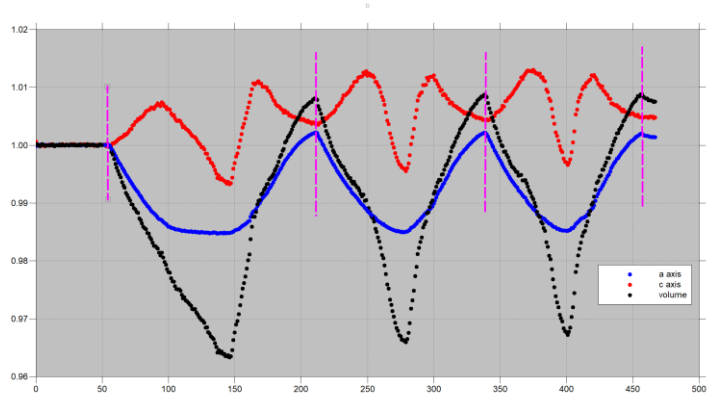
In-situ battery measurements using synchrotron and neutron diffraction







003 R



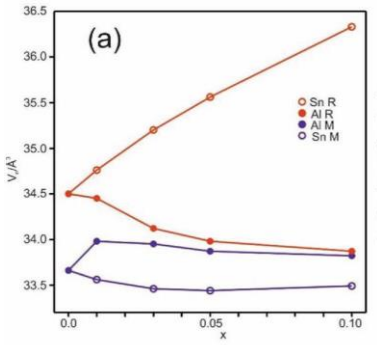
Journal of the Electrochemical Society: 10.1149/2.0291805jes

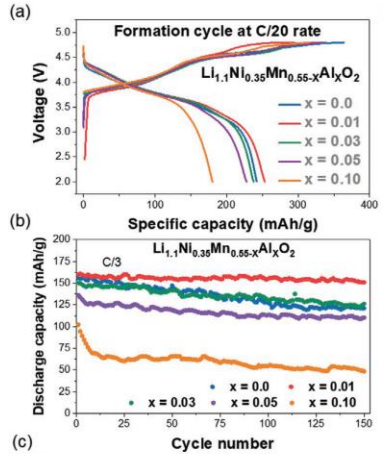
Chemistry of Materials: doi.org/10.1021/acs.chemmater.1c04150

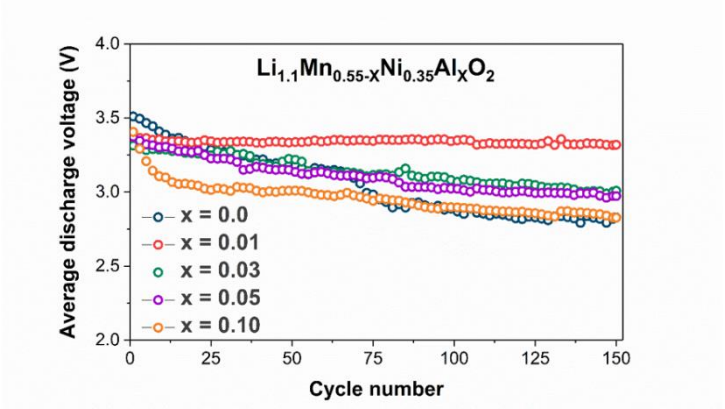
Co-free Al doping $Li_{1.1}Ni_{0.35}Mn_{0.55-x}Al_xO_2$

Exploring the nanoscale origin of performance enhancement in $Li_{1.1}Ni_{0.35}Mn_{0.55}O_2$ batteries due to chemical doping

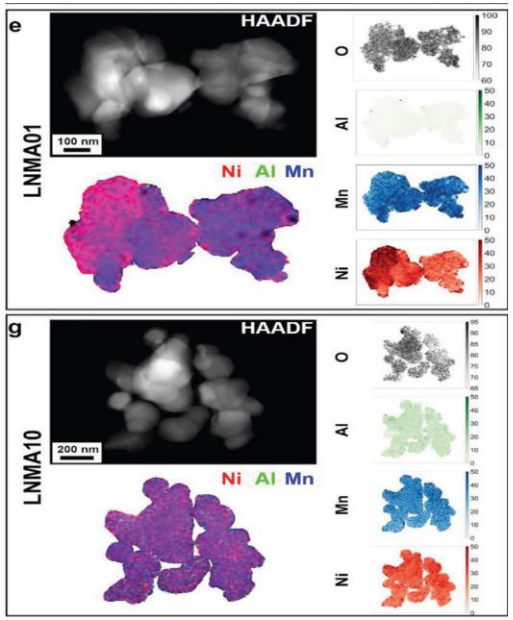
Sample label	M	x	Nominal chemical formula	TEM investigation	Notes
LNMO	–	–	$Li_{1.1}Ni_{0.35}Mn_{0.55}O_2$	Yes	Parent compound
LNMS01	Sn	0.01	$Li_{1.1}Ni_{0.35}Mn_{0.54}Sn_{0.01}O_2$	No	
LNMS03	Sn	0.03	$Li_{1.1}Ni_{0.35}Mn_{0.52}Sn_{0.03}O_2$	No	
LNMS05	Sn	0.05	$Li_{1.1}Ni_{0.35}Mn_{0.50}Sn_{0.05}O_2$	No	
LNMS10	Sn	0.10	$Li_{1.1}Ni_{0.35}Mn_{0.45}Sn_{0.10}O_2$	Yes	
LNMA01	Al	0.01	$Li_{1.1}Ni_{0.35}Mn_{0.54}Al_{0.01}O_2$	Yes	Best electrochemical performance
LNMA03	Al	0.03	$Li_{1.1}Ni_{0.35}Mn_{0.52}Al_{0.03}O_2$	No	
LNMA05	Al	0.05	$Li_{1.1}Ni_{0.35}Mn_{0.50}Al_{0.05}O_2$	No	
LNMA10	Al	0.10	$Li_{1.1}Ni_{0.35}Mn_{0.45}Al_{0.10}O_2$	Yes	



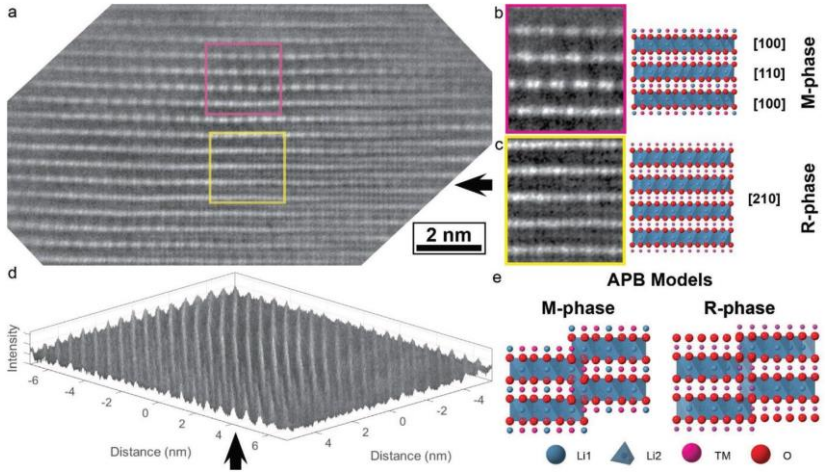




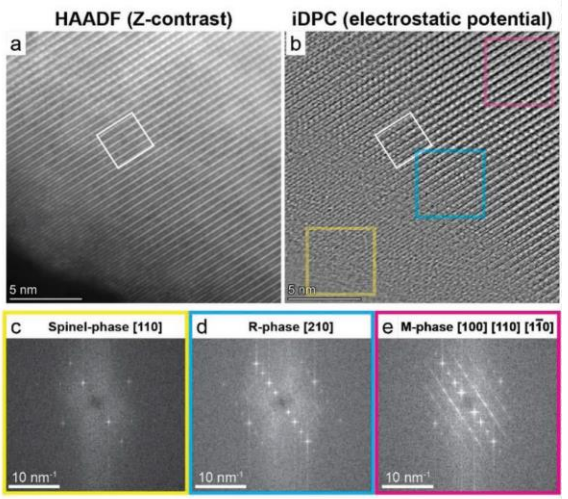
From bulk to nanodomain with Al doping



Formation of antiphase boundaries



Post-mortem analysis



Advanced Energy Materials:10.1002/aenm.202203889

Thank you!

Los resultados presentados son parte de la ayuda RYC2021-034994-I, financiada por MCIN/AEI/10.13039/501100011033 y por la Unión Europea «NextGenerationEU»/PRTR»

BATTECH

IREC eurecat

Thank you!