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Title

CRADA: Synthesis and Evaluation of NMC Cathode Materials

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1. Parties: California Clean Energy Fund (Prime: Volkswagen Group of America, Inc.)
2. Title of the Project: Synthesis and Evaluation of NMC Cathode Materials
3. Summary of the specific research and project accomplishments:
(Were the goals of the CRADA achieved? Include relevant information but do not include proprietary or protected CRADA information.) Yes. Embed from VW (Dr. Mirko Herrmann) wanted to learn synthesis and characterization of cathode materials belonging to the NMC family ($\text{LiNi}_x\text{Mn}_y\text{Co}_z\text{O}_2$). He synthesized materials, cycled them, and studied them using synchrotron X-ray techniques we use in our lab for this purpose.

4. Deliverables:

Deliverable Achieved	Party (LBNL, Participant, Both)	Delivered to Other Party?
N/A		
N/A		
N/A		

5. Identify publications or presentations at conferences directly related to the CRADA?
None
6. List of Subject Inventions and software developed under the CRADA:
(Please provide identifying numbers or other information.) None
7. A final abstract suitable for public release:
(Very brief description of the project and accomplishments without inclusion of any proprietary information or protected CRADA information.)

Ni-rich NMCs, technologically important cathode materials for lithium-ion batteries were synthesized and studied for this project. Electrodes were also harvested from cycled and/or aged commercial Li-ion cells and examined using high-throughput, ensemble average synchrotron soft x-ray absorption techniques developed at LBNL to

observe surface reconstruction in NMC materials (see F. Lin et al. **Nature Commun.** 5:3529, (2014)). A goal was to observe which cycling and storage conditions lead to degradation of cathode materials, a process that has been implicated in premature failure of the devices in some cases. VW provided pristine electrodes to use as baselines. Cells containing electrodes synthesized at LBNL were cycled or subjected to various storage conditions at LBNL, and VW also provided cycled or aged electrodes from commercial cells with histories of interest.

8. Benefits to DOE, LBNL, Participant and/or the U.S. economy. It was beneficial to me as the LBNL host to interact with someone in the automotive industry trying to develop batteries for electric vehicles and hear what the true concerns are. The participant from VW also benefitted from learning our characterization and synthesis techniques for materials that go into the batteries. The potential benefit to LBNL is the forging of strong relationships between car companies interested in development of electric vehicles and researchers at the lab working on materials for the batteries that go into the vehicles, which can lead to future work. Although VW is ostensibly a German company, they are partnering with some smaller vehicle manufacturers in the U.S. to transfer knowledge and innovation in this field, so that there is a positive impact on the U.S. economy.

9. Financial Contributions to the CRADA:

DOE Funding to LBNL	\$0.00
Participant Funding to LBNL	\$24,631.00
Participant In-Kind Contribution Value	\$0.00
Total of all Contributions	\$24,631.00