UNIVERSITY OF CALIFORNIA, IRVINE

THE DEPARTMENT OF MATERIALS SCIENCE AND ENGINEERING

Is Proud to Host a Seminar by:

ASSISTANT PROFESSOR RAPHAËLE CLÉMENT

Department of Materials Science
and Engineering
University of California, Santa Barbara

MATERIALS DESIGN FOR NEXT-GENERATION LI- AND NA-ION BATTERIES

DATE:
Thursday, April 4, 2024
TIME:
2:00 - 3:20 PM
LOCATION:
McDonnell Douglas Engineering Auditorium

Abstract: While batteries have become ubiquitous in our daily lives, rapid growth in demand requires the development of higher energy density devices, and lower cost and more sustainable battery chemistries. Sodium (Na)-based batteries and solid-state batteries are attractive alternatives to the current lithium (Li) technology. Yet, viable Na-ion cathode materials have proven elusive, and a paradigm shift in the development of competitive systems hinges on the investigation of structures that depart from those explored for Li. In addition, solid electrolyte development has been hampered by the difficulty to identify materials that are chemically and electrochemically stable during normal battery operation, while also exhibiting a high ionic conductivity. In this talk, I will present our recent work exploring new chemistries and crystal structures for Na-ion cathodes, and chloride-based solid electrolytes for Li- and Na-based solid-state devices. A common theme throughout is the combined use of solid-state NMR, X-ray diffraction, and first principles calculations to better understand the links between synthesis, composition/structure and electrochemical properties.

I will present our work on weberite-type Na-ion cathodes, where we explore the impact of polymorphism and metastability on their long-term performance. [1] I will also discuss our recent findings on high conductivity chloride-based solid electrolytes. [2—5] We find, in particular, that ion transport depends sensitively on planar defects and polymorphism, and can be increased through amorphization. Overall, our results unravel new rules for the rational design of battery materials.

Bio: Raphaële Clément is an Assistant Professor in the Materials Department at the University of California Santa Barbara since 2018. She received her Ph.D. in Chemistry in 2016 from the University of Cambridge, working under the supervision of Prof. Clare Grey. She then joined the group of Prof. Gerbrand Ceder as a postdoc at the University of California Berkeley. At UCSB, the Clément group is interested in establishing materials design rules, and in optimizing materials processing approaches to advance electrochemical energy storage. The group's expertise lies in the development and deployment of magnetic resonance techniques (experimental and computational) for the study of battery materials and beyond, with a strong emphasis on operando tools. She received an NSF CAREER award in 2022, the Materials Today Rising Star Award in 2023, as well as the ISE Prize in Electrochemical Materials Science from the International Society of Electrochemistry. She is a Topical Editor for ACS Energy Letters.

[1] Foley, E., Wu, V., Jin, W., Evans, H., Cui, W., Yoshida, E., Manche, A., Clément, R., Chem. Mater., 35(9), 3614-3627 (2023).

[2] Sebti, E., Evans, H., Chen, H., Richardson, P., White, K., Giovine, R., Koirala, K., Xu, Y., Gonzalez-Correa, E., Wang, C., Brown, C., Cheetham, A., Canepa, P., Clément, R., J. Am. Chem. Soc., 144, 5795 (2022).

[3] Wu, E., Banerjee, S., Tang, H., Richardson, P., Doux, J.-M., Qi, J., Zhu, Z., Grenier, A., Li, Y., Zhao, E., Deysher, G., Sebti, E., Nguyen, H., Stephens, R., Verbist, G., Chapman, K., Clément, R., Banerjee, A., Meng, Y. S., Ong, S. P., Nat. Commun., 12(1), 1256 (2021).

[4] Sebti, E., Qi, J., Richardson, P., Ridley, P., Wu, E., Banerjee, S., Giovine, R., Cronk, A., Ham, S.-Y., Meng, Y. S., Ong, S. P., Clément, R., J. Mater. Chem. A, 10 (40), 21565-21578 (2022).

[5] Ridley, P., Nguyen, L. H. B., Sebti, E., Duong, G., Chen, Y.-T., Sayahpour, B., Cronk, A., Deysher, G., Ham, S.-Y., Oh, J. A. S., Wu, E., Tan, D., Doux, J.-M., Clément, R., Jang, J., Meng, Y. S., "Amorphous and Nanocrystalline Halide Solid Electrolytes with Enhanced Sodium-ion Conductivity", Matter, 7(2), 485-499 (2024).