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Electrochemical energy storage beyond lithium: mechanisms revealed by in operando synchrotron studies

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Electrochemical energy storage beyond lithium is of high relevance for a sustainable energy technology. However, qualitatively new concepts are needed for suitable electrodes, especially in the case of the intercalation of larger monovalent ions like Na^+ or K^+ or multivalent ions like Mg^{2+}, Ca^{2+} or Zn^{2+}.
One example for a promising Na-ion battery is presented based on symmetrical NASICON-structured $Na_2VTi(PO_4)_3$ electrodes [1]. The contribution of in situ synchrotron diffraction and X-ray absorption spectroscopy to unravel the underlying sodium storage mechanism and charge compensation behaviour is presented.
Model systems for multivalent-ion insertion can also include hybrid batteries with two mobile metal ions in the electrolyte, where a metal like Mg is plated at the negative electrode, while Li- or Na-ions are inserted at the positive electrode [2,3]. This presentation summarizes some recent results on the underlying working mechanisms in such hybrid batteries as revealed by in operando diffraction using synchrotron radiation in combination with X-ray photoelectron spectroscopy (XPS).
[1] D. Wang, et al., Nat. Commun. 8 (2017) 15888.
[2] X. Bian, et al., Mater. Chem. A, 2017, 5, 600.
[3] Q. Fu, et al., Electrochemical and structural investigations of different polymorphs of TiO_2 in magnesium and hybrid lithium/magnesium batteries, Electrochim. Acta, subm.

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