



Molecular Processes in Intercalation and Redox Flow Batteries

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Batteries play an ever growing role in today's and future technologies. Applications can range from portable electronics over electrification of road traffic to using renewable energies 24h/365d. Demands on the performance are thus very different and a thorough understanding is a pre-requisite for further improvement. In particular, a detailed understanding of the molecular processes is important for energy and power density, cycle life (degradation mechanisms) and safety of batteries. Two types of batteries will be discussed, intercalation batteries and redox flow batteries.

Intercalation batteries have become an important technology for electricity storage as can be seen from the success of Li-ion batteries. Since there are issues regarding the broad availability of lithium, attempts are made to have other ions intercalated such as magnesium and sodium. In addition, the molecular understanding of the processes, especially at the interface, are still underdeveloped. Studies were performed using Scanning Tunnelling Microscopy (STM) and other techniques to investigate

- the electrochemical behaviour of the ion intercalation for Li and Na,
- the molecular processes upon formation of the SEI in a Li-ion battery,
- the intercalation process of Na in HOPG in glyme electrolyte.

The current technology of redox flow batteries, RFB, uses the $V^{2+/3+}$ - $V^{4+/5+}$ redox couple for storing electricity. This all-vanadium system has many advantages, most importantly, there is no chemical contamination through cross diffusion over the membrane by vanadium. There are, however, some performance issues with this system and a deeper molecular understanding of the redox processes is important. Experiments will be discussed how surface functional groups on the carbon of the electrodes can considerably influence the rate of the redox reaction. Further on, anion effects seem to play an important role for redox kinetics. Alternative redox systems that can provide a considerably higher power and energy density, such as polyoxometalate will be presented and future strategies be discussed.

References

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