Secondary Sodium Ion Batteries: Organic and Inorganic Electrode Materials for Post-Lithium Chemistries

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Sustainable energy storage using rechargeable batteries represents one of the great challenges in the twenty-first century. This talk is dedicated to discuss challenges and chances in innovative concepts, chemistries and architectures for advanced sodium (Na) ion secondary battery systems. In the first part of this talk, quinones,[1] which are a fascinating type of organic battery material, comprising a high theoretical capacity, fast reaction kinetics and a large structural diversity, are addressed. Recent advances using pigments containing benzoquinone units, for example, anthraquinone (AQ) in comparison to perylentetracarboxylicdiimide (PTCDI), as active material for Na ion battery electrodes, are presented. AQ and PTCDI on carbon paper substrates are used to fabricate stable electrode composites, whereby the nanostructured carbon adds potential advantages, mainly its large surface area, ordered porous network, large pore volume, good electrical conductivity and low cost. The second part of this talk reports on the sodiation and desodiation characteristics of anodically grown, self-organized titanium dioxide (TiO_2) nanotubes. Interestingly, carbon treated, anatase TiO_{2-x}-C nanotubes show substantial self-improving charge storage capacities as cycling proceeds, leading to high specific capacities. Subsequent kinetic analysis reveals a pseudocapacitive contribution which dominates the Na storage process at fast sodiation rates. This pseudocapacitance in TiO_{2-x}-C nanotubes is found to enable exceptionally high-rate capabilities with high specific capacities at elevated current rates of up to 20C.[3]

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[1] B. Häupler, A. Wild, U. S. Schubert, *Adv. Energy Mater.* **2015**, *5*, 1402034.

[2] D. Werner, D. H. Apaydin, E. Portenkirchner, *Batter. Supercaps* **2018**, *1*, 160–168.

[3] E. Portenkirchner, D. Werner, S. Liebl, D. Stock, A. Auer, J. Kunze-Liebhäuser, *ACS Appl. Energy Mater.* **2018**, *1*, 6646–6653.