Function through Defects: From Solid State Ionics to Energy Research

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Mobile ions in solids enable a palette of applications in particular in the field of energy research and cannot be rendered dispensable by using electrons. Typical examples are fuel cells and batteries. The concentration of ionic and electronic charge carriers can be tuned by stoichiometry, doping, temperature, pressure and in special cases even by light (see Fig. 1) [1].

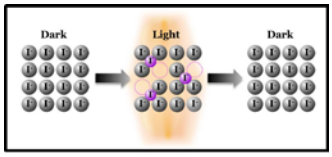

Figure 1

In this contribution emphasize is laid on “nanoionics” [2].

Not only can the introduction of interfaces and the variation of their spacing drastically vary conductivities, also qualitative changes can be achieved: insulators can be turned into conductors, electronic conductors into ion conductors, anion into cation conductors and interstitial into vacancy conductors (see Fig. 2). In its extreme, size effects can lead to the generation of artificial mesoscopic ion conductors [3]. Though nanoionic effects also proved to be of significance for various fields such as reaction kinetics, sensing, superconductivity research or photo-electrochemistry, the lecture emphasizes the impact on electrochemical storage devices such as lithium-based batteries. Here striking size effects occur not only in terms of cell voltage or ion transport in the electrolytes but also in terms of storage kinetics and storage

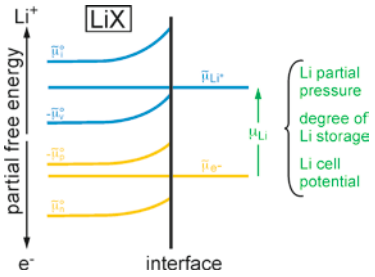

Figure 2

mechanisms (“job-sharing” mechanism, nano-dot reaction confinement) [4,5].

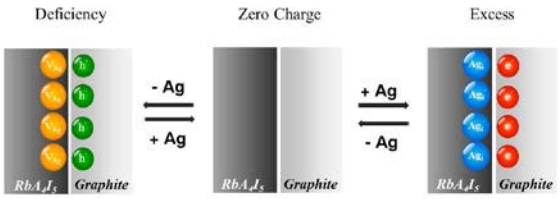

Figure 3

According to this, composites of phases which do not store mass individually, can do this synergistically (Fig. 3). In the extreme mesoscopic case of artificial electrodes the dichotomy between energy and power density may be resolved

References

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