New batteries demand new electrolyte concepts?!

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With several next generation battery (NGB) technologies emerging it could be expected that their optimized electrolytes must differ and we would need several ways to rationally optimize them. The difference could be of only a minor nature, for example by simply replacing the $LiPF_6$ salt of lithium-ion batteries (LIBs) for $NaPF_6$ at more or less the same concentration when creating electrolytes for sodium-ion batteries (SIBs) [1], or be much more profound, for example some of the quite special electrolytes launched for Mg-batteries [2,3].

Herein a smorgasbord of NGBs will be outlined from an electrolyte point-of-view, with examples of the opportunities and demands these create, including some more conceptual in terms of R&D tools and strategies. Design, composition and characterisation are all emphasized, but also different practical key performance indicators.

For example, within Li-S battery electrolytes the transport and solvation dynamics of polysulfides is crucial to the Li-S cell operation and at the same time the composition of the electrolyte is itself a function of the battery state-of-charge [4]. This has by us been targeted both by non-traditional electrolyte modelling approaches [5,6] as well as *operando* experiments [7]. For Li-air batteries the oxygen solubility in the electrolyte is one property that needs to be addressed – and the role of the Li-salt can be crucial [8]. Overall, many Li-battery concepts diverging from LiBs (Li-S, Li-air, Li-metal) open for applying other Li-salts than the prevailing $LiPF_6$ [9]. A special example where also the solvent must be altered are high-temperature LIBs, which can rely on ionic liquid based matrices [10]. Especially challenging are electrolytes designed for NGBs based on plating and stripping at a metal interface, not only for Li and Mg metal negatives, but also for Ca and Al-batteries [11].

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