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Editorial

More patience—a plea for longer stability testing and systematic data reporting

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A brief look at publications in this journal, as well as many other journals covering materials and systems for electrochemical energy conversion and storage, confirms the impression that mostly electrochemical materials science in terms of electrode materials, sometimes electrolytes and electrocatalysts, is at work. Once a study of a newly developed material for a battery or supercapacitor electrode is (barely) completed, the authors rush to report. In their enthusiastic excitement, they frequently calculate energy and power density for a single electrode, apparently happily clueless about the absence of single-electrode batteries and capacitors. Reporting charge densities with specification of the explored electrode potential range would be fine [1], and stating explicitly whether only the active material, or the complete electrode material including binder and conductive additives, even the support and current collector, has been included in calculating said charge density would be fine! In case of a complete cell (the terms *full cell* or *full battery* are hardly helpful because they commonly refer to the state of charge), the same applies. Setting up a Ragone plot for a single electrode (material) is obviously baseless, too, but very popular. Disappointed authors afraid to lose their chance to demonstrate the high current capabilities of their electrode have a popular and well-established option: display the capacity, i.e., charge storage capability, retention as a function of applied current!

The second aspect addressed in the title is experimental studies of material and device stability. Certainly, storage and power capabilities are interesting and fascinating, with poor performance on these points, a material is most likely of very small and limited interest for further investigation, not to speak of development. But beyond this, the stability of these data is of major importance. No consumer or user is going to buy a device showing the promised performance only for a few charge/discharge cycles or a few months. Of course, the expected number of cycles depends on the intended application. A secondary battery for a mobile phone, which will be exchanged by the user for a new model with even more gadgets and features after about two years (whether this is an example of sustainability is another question, and perhaps this habit similar to fast fashion in other fields of society and economies is indeed likely to fade sometime) is burdened with much lower expectations than the cells for an electric vehicle or a battery power station expected to work for ten or more years. Accordingly, an electrode (or cell) performance stable for less than 100 cycles is hardly more than a suggestion for further

thorough studies of the causes of the degradation and failure. Instead cycle numbers for batteries between 1000 and 2000 should be the aim [2] as proposed by various national and international agencies.

With supercapacitors and their materials, the situation appears to be even worse. Manufacturers of double-layer (EDLC) capacitors claim millions of charge/discharge cycles without hitting the generally accepted "failure limits" (20% nominal capacity loss and/or doubling of the internal resistance). With this in mind, cycle numbers of a few hundred or maybe 2000 are simply unrealistic or more flatly irrelevant—but are reported nevertheless. A simple estimate suggests that running 10,000 cycles with 26 s duration of a single cycle needs three days—an extended weekend! It is hard to imagine serious reasons for not conducting this experiment with a simple and quite common cycling instrument. Security concerns regarding unsupervised long-term experiments, once thrown at the present author by another professor of physical chemistry who glimpsed a low current electrolysis running overnight in the author's lab, can certainly be mitigated by running the cycling in a suitable laboratory with all safety precautions at industry standards. The extra effort will certainly be appreciated by the scientific community!

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