CHEMISTRY OF MATERIALS

Editorial

pubs.acs.org/cm

The Experimental Section: The Key to Longevity of Your Research

One of the greatest compliments anyone can give your published work is to reproduce it and build upon it. Your discovery starts to take on a life of its own, which is one of the strongest indicators that your work is meaningful, broadly speaking, to the scientific community. Seeing that others have learned from your own scientific research effort, and accompanying sweat, tears, and sheer hard work, is incredibly satisfying. While citations are important, it is about how many people you, in essence, have taught and now **do what you do**. For others to "do what you do", an excellent experimental section is an essential component of your published paper. Science can only progress if you, as an author, are as open and inclusive with respect to details as possible, to enable future readers to learn from you, and build upon your work.

While citations are important, it is about how many people you, in essence, have taught and now **do what you do**.

The scientific endeavor involves the discovery and creation of new ideas. Many of these do not stand the test of time and are abandoned, and those with merit are adopted and built upon. This effort is difficult and painstakingly slow and, unfortunately, is made even slower when experimental sections in many papers in a field are missing crucial details that enable successful replication, or worse, are critically flawed in a manner that is not apparent from the description of the experimental details. Only after wasting time trying to repeat the work does it become obvious that it is not reproducible. Irreproducible papers can cause enormous and undocumented harm because of the time wasted in the lab, or *in silico*, in the case of theoretical work. Those most affected tend to be younger scientists, the graduate students and postdoctoral associates working at the bench; the long-term impacts of their ensuing frustration can go beyond "simply" impeding their progress toward a degree or a job, as it could lead to their disillusionment with science altogether. There are only two reasons we can see that result in irreproducible papers, and neither is particularly flattering—one is sheer carelessness, and the other is a misguided attempt at obtaining or maintaining a competitive advantage. The latter, intentionally withholding critical details, can only result in very short-term gains (i.e., your peers cannot replicate your results, thus slowing their progress), but very profound long-term losses—your work has no impact within the scientific community, and your future papers are viewed with a skeptical eye, or simply ignored.

Experimental sections are, therefore, key to the longevity and continued impact of your research. So, how does one approach writing this critical section? Since your research is novel and original, you, the authors of the manuscript, are the only ones in the world who, at present, know how to carry out your experiments. Papers should never sweep important, and sometimes subtle, details under the rug. In new and emerging fields especially, the experimental section can be daunting to write as there is often no standard nomenclature and the procedures are not well-established, making it necessary to provide a lot more detail than required for well-established fields. We have a few suggestions to help ensure future reproducibility:

(i) Provide as much detail as is feasible. If a particular parameter is tricky or absolutely critical for successfully completing an experiment, state it and describe how you controlled it or attempted to control it. Include details about what should be observed during the procedure—is there a color change or some observable characteristic that you look for to indicate that things are progressing in the right direction? What is the typical yield of each step? Provide statistics to indicate how much variability should be expected when carrying out the work. These details are important—they can catalyze the adoption of your methods by providing a specific goal for those willing to take the next step and make your methods even better. Reproducibility can often depend on an unusual or atypical feature, for instance, the use a specific type of vessel, a reagent from a particular commercial source, or other parameter—if so, let your reader know. Put yourself in the shoes of an experienced colleague or graduate student "skilled in the art" and ask yourself the following: Would they be able to replicate your results after a couple of attempts?

(ii) Use the Supporting Information (SI) section for extra details, movies, and photos. You are free to include additional written details, photographs of experimental apparatus, and movies to demonstrate procedures. The oft-used adage of "pictures speak a thousand words" is certainly true, and you can almost hear the exclamation of "oh, now I get it" each time a movie is downloaded and watched. A movie may be a simpler and more direct way to make a point than a long and drawn out textual description of an apparatus, in some cases. Sometimes, the experimental details that you, the author, consider to be obvious may not be so evident for others—movies and photos help with the sharing of this more subtle information with readers.

Use the Supporting Information (SI) section for extra details, movies, and photos.

As practicing materials chemists and engineers, we know that, when writing a paper, the experimental section is often seen as a tedious stage through which an author must suffer on the road to publication. It is true that the experimental section may lack the up-front glory, but these details enable the research community to build upon your results, leading to the longevity of your hard work. Papers with long-term impact are those that serve to inspire new work and become the foundation for future experiments and research by others well into the future. The

Published: March 11, 2014

   dx.doi.org/10.1021/cm500632c | *Chem. Mater.* 2014, 26, 1765−1766

results and discussion section of a paper certainly conveys the importance of the work and provides the inspiration for others to notice, but once a researcher decides to shape their own work around yours, it is the experimental section that becomes the most essential component of the paper and most likely will determine if your work will matter—whether it will stand the test of time.

Jillian M. Buriak, Editor-in-Chief

Brian Korgel, Editor

AUTHOR INFORMATION

Notes

Views expressed in this editorial are those of the authors and not necessarily the views of the ACS.

dx.doi.org/10.1021/cm500632c | *Chem. Mater.* 2014, 26, 1765−1766