

## How to Make Your Next Paper Scientifically Effective

Not too long ago, scientific publications were written in a quite rigid and conservative format. The presentation of results was usually made using a passive voice, and personal pronouns were avoided. There was no provision for including color graphics, and TOC graphics were unheard of. There was no electronic access to published papers or any electronic database. One simply had to wait for new journal issues to arrive in the library to access newly published articles.

During the past few years, the presentation of scientific results has evolved into a new format. Today, prominent and high-impact scientific journals publish papers in a more glamorous way. A large number of papers published today include artistically attractive schemes, color graphics, and prose that appeal to a general readership. The availability of computer software for designing figures and illustrations and allowing data to be presented in color has added a new dimension to the publication of scientific research. Personal pronouns and active voice are now freely used in sentences, creating a more personal and engaging narrative. On the other hand, the number of submissions rejected by the journal editorial offices without external review is on the rise across all major journals. Authors of these rejected papers are often left to wonder why their papers were not considered for publication. In a previous editorial, we highlighted the importance of meeting submission criteria in order to avoid rejection without external review.<sup>1</sup> Whitesides, in 2004, nicely presented the basic structure of the research paper and discussed some important aspects to consider while writing one.<sup>2</sup> Science journalism has evolved considerably since then. This Editorial highlights a few additional steps that can aid in composing an effective scientific paper.

According to a publication of National Academic Press, "The object of research is to extend human knowledge beyond what is already known. An individual's knowledge enters the domain of science only after it is presented to others in such a fashion that they can independently judge its validity."<sup>3</sup> Hence, the way we communicate our scientific research findings becomes an integral part of the research activity.

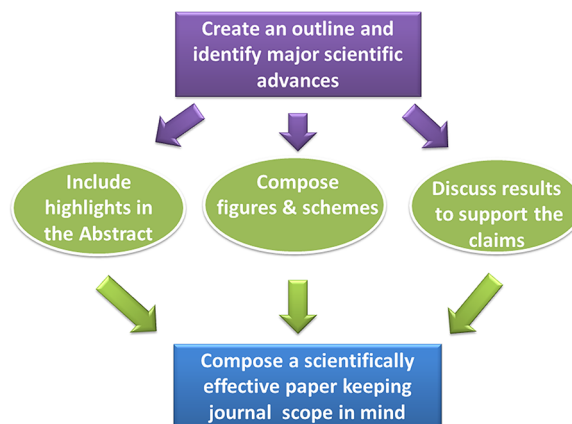
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A well composed paper clearly stands out, gaining the prompt attention of editors, reviewers, and readers. Editors are interested in considering papers that are within their journal's scope and will be well appreciated by their readership. Such a demand puts the burden on the authors to generate effective scientific papers and present their results in articulate ways. We at *The Journal of Physical Chemistry Letters* (JPCL) are committed to publishing papers that represent significant scientific advances within the scope of physical chemistry and whose scientific results merit urgent communication.

We strongly urge our authors to consult the guidelines while preparing manuscripts for submission to JPCL ([http://pubs.acs.org/paragonplus/submission/jpachax/jpclcd\\_authguide.pdf](http://pubs.acs.org/paragonplus/submission/jpachax/jpclcd_authguide.pdf)). Authors may also find the following tips useful.

**Outline and Journal Choice.** The first step before writing the paper is to create an outline (Chart 1). You need to gather all

Chart 1. Key Steps in Composing a Scientifically Effective Paper



data and identify the major advances that emerged from the study. Generally, it makes the most sense to create a figure-based outline in which you list the major results of your study and organize them into different anticipated figures. The outline should include the order of the data presentation so that a short scientific story emerges. Proper presentation is crucial to bringing significant interest among the journal readership. The next step is to select the journal in which your new findings will be communicated. The choice of the journal should be based on the scope of your investigation, and it should not be based on the journal impact factor. Carefully read the journal's "Authors' Instructions" and find out the specific format and submission requirements. If there are questions about who should be the authors, the COPE (Committee on Publication Ethics) Guidelines (<http://publicationethics.org/resources/guidelines>) should be consulted.

The choice of the journal should be based on the scope of your investigation, and it should not be based on the journal impact factor.

**Title.** An important step in writing the paper is to come up with an attractive title that will appeal to a broad readership. The title should be simple, effective, and accurately reflect the

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content of the paper. If you are submitting a paper to a physical chemistry journal, avoid using phrases such as *Synthesis*, *Device Fabrication*, or *Application* in the title as they imply the focus of the paper is highly specialized in nature. Descriptive words such as *Study*, *Investigation*, or *Demonstration* should also be avoided because they can undermine the uniqueness of the study. Similarly, avoid adjectives such as *Significant Enhancement*, *Highly Efficient*, *Novel*, *Facile*, or *Green* unless you have a major finding that conclusively supports the claim. Excessive and unnecessary use of these types of adjectives can discredit or lessen the paper's appeal. Because all scientific papers report novel results, there is no need to emphasize novelty in the title or in the text. A quick search for the phrases *novel*, *highly efficient*, or *significant enhancement* in the *Web of Science* (Thomson Reuters) yields hundreds of catalysis and photocatalysis papers published during the last 2 years. Interestingly, many of these papers do not even report actual measured efficiencies nor do they consider the fact that the measured efficiency is based on the use of a sacrificial system. Another faux pas to avoid is the insertion of a series of keywords in the title. Such titles become unattractive and fail to draw the attention of readers. (Tip: Write 3–4 different titles and get the opinion of group members and colleagues.)

**Abstract.** The next major part of the paper is the abstract, which is a summary of the work being discussed in the paper. An abstract should be written in such a way that any reader who is not familiar with the topic will be able to understand and appreciate the main points of the study. One or two sentences that clearly highlight significant new findings and/or advances should be made the centerpiece. A couple of sentences indicating the methodology and key observations should be included to provide the scope of the study. Finally, the abstract should end with a sentence summarizing the implication of the study in a broader context (e.g., possible applications) that highlights the importance of the work being presented. Because the abstract is evaluated by both the editors and general readers, extra effort should be taken to compose an effective and concise abstract, keeping it to 150 words or less for *JPCL* papers. Examples of effective abstracts are available in the *JPCL* author guidelines (Appendix A).

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**TOC Graphics.** The purpose of a Table of Content (TOC) graphic is to summarize the theme of the scientific paper in a graphical way. TOC graphics are an excellent platform designed to grab the attention of the readers. A simple scheme or illustration provides the best clarity and will draw the readers' attention to the paper. Because the TOC graphic is printed adjacent to the abstract of papers published in *JPCL* and other ACS journals, do not use a figure from the manuscript as the TOC graphic in order to avoid duplication. Refer to examples of TOC graphics presented in the *JPCL* author guidelines (Appendix B).

**Figures.** The figures are the heart of a paper as they deliver the data in a concise, orderly fashion. Well-drawn figures give

the readers the greatest number of ideas in the shortest time and with the least ink in the smallest space.<sup>4</sup> Figures should communicate ideas with clarity, precision, and readability. Graphics, if framed in a golden rectangle (ratio of sides being 1.6) with the horizontal side greater in length than the height, are aesthetically pleasing.<sup>4</sup> Getting rid of the grid lines that accompany graphs from spreadsheet software, adjusting the scale bars in order to have a reasonable number of items on each axis, and maintaining a consistent and large font size are additional ways to further enhance the scope of figures.

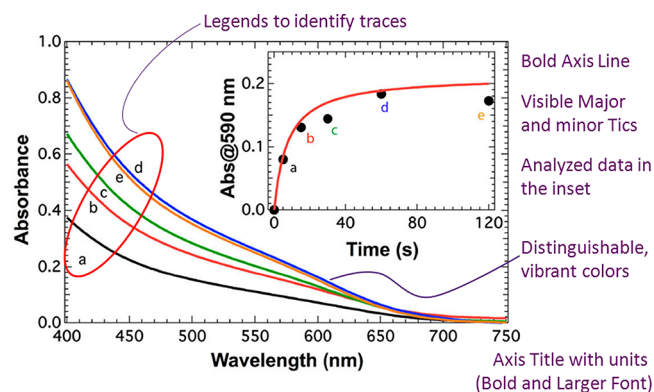
Well-drawn figures are the heart of a paper as they deliver the data in a concise, orderly fashion.

When presenting data with a trend line or analytical fit, confirm that there is causality between the *x*- and *y*-variables. If you are presenting data of different samples (with no direct relationship in terms of a given property), do not “connect the dots”. Determine whether a bar diagram would be a better way to present the data in such circumstances. Before scientific software and spreadsheets became readily available, there were no point-to-point connected trend lines appearing in figures. In the good old days, trend lines were drawn by hand by authors using French curves!

Another important aspect is the axis title and units. Each axis should have a title and corresponding unit, if any. Avoid using symbols as the axes titles. Verify that the units employed are correct. Do not add units that can mislead the readers. An increasingly common but erroneous practice is to represent absorbance with units of “a.u.” (arbitrary units.) Absorbance, the log of the intensity ratio, has no units. To indicate that it has arbitrary units is misleading. Because absorbance is a measurable quantity, actual values should be presented on the *y*-axis. It is important to know the differences among relative, normalized, and arbitrary scales before using these adjectives on the *y*-axis title. Another factor to consider is significant digits. For example, there is a difference between 0.02 and 0.0200 values as they represent different levels of accuracy in the measurements. Use your judgment before reproducing results from the computer display.

Make sure all symbols are accurately identified in the figure caption or legend. Do not fill in figures with too much text or

Chart 2. Example of an Experimental Data Presentation<sup>a</sup>



<sup>a</sup>A few items in the figure are highlighted for clarity and accuracy of the presentation. (Tip: Use bolder fonts outside of the frame and lighter fonts inside of the frame.) Adapted from ref 5.

clutter. Too many overlapping traces hinder data readability. In general, each figure should have one clear, unified message. If it makes sense to break a figure up into different panels to better illustrate different subfindings, then do it. All text in the figure and scheme should be clearly readable at 100% page magnification. Colored figures can significantly enhance the clarity of data presentation. *JPCL* and other ACS journals publish color figures free of charge. Extra care should be taken in selecting the appropriate font size and color combination in figures (see, for example, Chart 2). It is recommended that traces be labeled (a, b, c, etc.) and these labels be explained in the figure caption. Traces identified solely by color (e.g., blue, red, green) can present difficulties to color-blind people as well as anyone reading the article after it has been printed out on a black and white printer.

**Main Text.** The writing style used in the main text, including discussion of results, is a personal choice as every author has his/her own characteristic writing style. The style, however, can make a large difference in the reader's ability to comprehend your message and the study. Because the purpose of the scientific paper is to communicate scientific advances, it is important to write grammatically correct sentences. A simple style of composing the text with short sentences rather than long and complex sentences is preferred. It is important to keep the diverse journal readership in mind when writing. The more easily your readers can understand your paper, the more likely they will be to enjoy and appreciate it. Writing clearly and concisely will enhance an elegant study, rather than diminish it.

The Introduction is arguably one of the most difficult parts of a paper for many authors. If you think of your article as a story or essay, the way you begin and frame the narrative is key. A good introduction requires that the authors fully understand the significance of their work and how it fits in with the current state of knowledge in a specific area. Write an introduction that generates a story, draws the reader into your study, and clearly defines the message you wish to share. Start with two or three introductory paragraphs to present recent advances, motivation for conducting the study, and scientific issues being addressed in the paper.

A good introduction requires that the authors fully understand the significance of their work and how it fits in with the current knowledge in a specific area.

The next part of the main text is the presentation of the data and related scientific discussion. Remember to select representative results that support the major findings that were included in the abstract. The scientific presentation should flow smoothly so that the readers are compelled to read the entire paper. By comparing (or contrasting) observations with previous results within a healthy scientific discussion, you can bring significant strength to the manuscript. The bottom line is to keep the scientific story simple and focused so that a general readership can appreciate the new findings. Remember to check for accurate referencing of figures and traces in the text. All additional supporting data should be moved to Supporting Information, thus avoiding the dilution of the main results.

A concluding paragraph adds a special touch to the paper and further aids in increasing the impact of research. You should

not repeat the phrases that you have already mentioned in the abstract. This is the place to inject some bold remarks that reflect the outcome of the study. You can also identify issues and challenges that can be addressed in future studies.

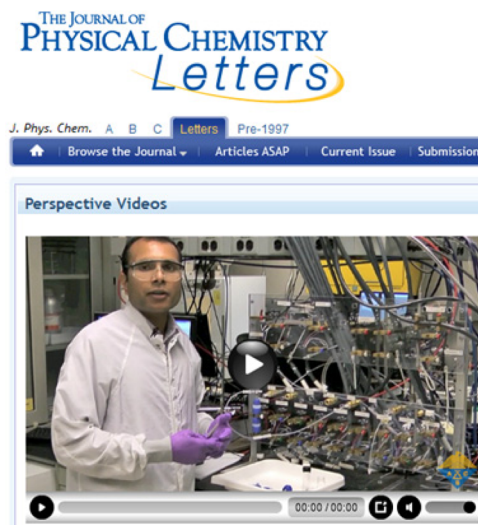
**Experimental Methods.** In *JPCL* and many other newer journals, the experimental section is presented at the end of the text. Provide all of the experimental methods and procedures so that other scientists can reproduce your results, if needed. Include an acknowledgment thanking the funding agency and any others who might have contributed to the study.

**References.** The availability of reference databases to download citations has made referencing relevant papers easier than ever. *JPCL* requires authors to include titles of all references (written in title case) and full page ranges. (Please refer to the author guidelines to see *JPCL*'s complete reference format.) Authors should refrain from excessive self-citations. It is important to keep the journal scope in mind while discussing relevant scientific papers. If the majority of your citations are from specialized journals, the editor may refer you to a journal specialized in a specific topic.

Authors now find it necessary to explore new approaches to communicate their research and connect with media-savvy readers.

**Multimedia.** The electronic era has brought new dimensions to disseminate scientific research. For example, *JPCL* regularly posts author-narrated Perspective videos to provide a quick visual touch to the emerging topics discussed in the Perspectives (Chart 3). *JPCL* now offers web-enhanced objects

Chart 3. *JPCL* Offers Several Multimedia Platforms Including Perspective Videos and Live Slides to Highlight Scientific Advances in Emerging Fields<sup>a</sup>



<sup>a</sup>The author-narrated videos are catalogued on the *JPCL* homepage (Reference 6).

and Live Slides features. *Mobile apps* allow scientists to download the latest research even when away from their desks.

**Quick Checklist**

- ❖ Is the title appealing to broader readership?
- ❖ Have significant findings been identified in the abstract?
- ❖ Does the introduction provide motivation for the study?
- ❖ Are the figures and schemes scientifically correct and aesthetically pleasing?
- ❖ Do the discussion of results and cited references fall within the scope of the journal?
- ❖ Is the discussion centered on the main theme of the paper?
- ❖ Have proper acknowledgements been made?
- ❖ Have all coauthors seen and commented on the final draft of the manuscript?

(5) Santra, P. K.; Nair, P. V.; Thomas, K. G.; Kamat, P. V. CuInS<sub>2</sub> Sensitized Quantum Dot Solar Cell. Electrophoretic Deposition, Excited State Dynamics and Photovoltaic Performance. *J. Phys. Chem. Lett.* **2013**, *4*, 722–729.

(6) The Perspective video catalogue is available at <http://pubs.acs.org/page/jpclcd/video/perspectives.html>.

The availability of new media features, however, has imposed additional burdens on the authors. Authors now find it necessary to explore new approaches to communicate their research and connect with media-savvy readers.

Once the writing task has been completed, carefully proofread the paper and then pass it on to coauthors, friends, and/or colleagues for their feedback. Ask them to provide you with a critical review so that you can further improve the presentation. It is important to have the papers reviewed internally by one or two colleagues before formal submission to a journal. A paper with nicely presented, complete, and accurate information will sail through the review process with a greater chance of success. Once published, well-composed, meaningful papers are read and frequently cited by other scientists. A little extra effort and care in preparing the manuscript makes a large difference in terms of the paper's impact.

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### Notes

Views expressed in this Editorial are those of the authors and not necessarily the views of the ACS. Readers should exercise their own judgment during manuscript preparation because the topic of study and journal scope varies.

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## ■ REFERENCES

(1) Kamat, P. V.; Schatz, G. C. Getting your Submission Right and Avoiding Rejection. *J. Phys. Chem. Lett.* **2012**, *3*, 3088–3089.

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(4) Tufte, E. R. *The Visual Display of Quantitative Information*; Graphics Press: Cheshire, CT, 1983; pp 1–197.