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Editorial

Writing a scientific paper: II. Introduction and references

In my first Editorial in this series, Titles and Abstracts [Carbon 2007;45(11):2143–4], I said: “Although these items are the first in the paper, they have to be written last. It is impossible to abstract something that has not been written! (However) they are usually added as something necessary to complete the submission, and little or no thought is given to them.” Now we come to the Introduction that is necessarily at the beginning of the main text but should, I believe, not be written before the other sections. The reason why I am including the References here is because they are inextricably linked to the Introduction, as we shall see.

I am aware that many people, including some of my valuable and highly respected reviewers, will not agree with my thoughts on the Introduction to a paper, and I guess there are essentially two opinions that must be respected. One sees this section as giving a complete introduction to the subject and to the materials and techniques used in the manuscript, and the other as an introduction to the manuscript itself. The first can be very long while the second, much shorter. I find myself in the latter category. What introductory background does the reader need in order to understand the manuscript and place it in context?

Papers on the current “hot topic” of carbon nanotubes (CNTs) are an excellent example. I randomly (honestly!) selected a paper from a past issue of CARBON from the shelf in my office. It concerned CNT growth using CVD, and the first paragraph reads as given below. Any comments I make are not aimed at the authors of this one paper. There are hundreds of papers for which the same comments apply.

“CNTs are a recently discovered form of carbon with a graphitic lattice and a long, tubular structure [1]. CNTs have been the subject of much interest in recent years, due to their attractive mechanical properties (~1000 GPa Young’s modulus) [2–4], tuneable electronic behavior (conducting or semi-conducting depending on tube chirality) [5] and unique dimensions (~1–100 nm diameter, up to several cm length) [6–8]. As a result of these properties, nanotubes have potential applications in many fields, including composite reinforcement [9,10], transistors and logic circuits [11,12] field emission sources [13], and hydrogen storage [14,15]. CNTs can be grown by a variety of means, the most common of which are: arc discharge [16], laser ablation [17], and chemical vapor deposition (CVD) [18,19].”

Now you can perhaps see why I have linked References with the Introduction. We already have 19 references, more

than 50% of the total number in the manuscript. These occupy almost a single printed column in the journal, and 15 of them have nothing to do with the thrust of the paper, viz. CNT growth. Is any prospective reader of this paper in CARBON going to be unaware of the “discovery” of CNTs by Iijima [read the Guest Editorial “Who should be given the credit for the discovery of carbon nanotubes?” Carbon 2006;44(9):1621–3] or of their basic structure and properties? If we may assume these facts to be known by any person likely to read the ms, the Introduction could well begin: “*The three most common methods for carbon nanotube (CNT) growth are: arc discharge [1], laser ablation [2], and chemical vapor deposition (CVD) [3,4].*”

Recently I received a manuscript on the production of activated carbon from various agricultural waste materials. The first part of the introduction was simply a catalogue of all (?) agricultural precursors that have been investigated for activated carbon production. Any potential reader of the paper would be aware of the vast number of organic precursors that have been examined for this purpose. There is no need to list them all each time a paper on the subject is written. The paper has been rejected for other reasons, but it serves as an illustration of the point being made here. With such an Introduction one could easily have 50–100 references before one gets started!

Another manuscript reported the production of a flexible carbon “nanobelt” which is, I assume, the same as a nanoribbon. In spite of the fact that the product is not a nanotube, the authors started their Introduction with the famous Iijima paper and proceeded to list all possible production methods and potential applications for carbon nanotubes before considering other nanostructures that have been reported. Of course at this point the paper already had a long list of references, none of which was really relevant to the subject of the manuscript.

The Introduction should consist of a few paragraphs (perhaps no more than two) that define the context for the current work reported. How does this paper relate to what has been done previously? In the process it should point readers to publications to which they may need to refer in order to understand the motives for the current research. That’s all!

The depth of background history provided by some Introductions makes me wonder (cynically) why they don’t start with the discovery of the electron, and then discuss chemical bonding, Bragg’s work on crystal structures, etc. We would all

find such an approach absurd, but many Introductions are nearly as bad.

Two days after writing the previous paragraph I received a manuscript that was almost a perfect example. The paper began by informing us in the Introduction that (I am not quoting exactly): “Carbon is the most versatile element on the earth. Two forms, diamond and graphite, were discovered in the 18th century. There then followed 200 years with no major advances until the discovery of fullerenes in 1985, for which Nobel prizes were awarded. Etc.” Not only is this not a suitable introduction for a research paper, it is also wrong. Advances such as mesophase, carbon fibers and filaments are overlooked. Or perhaps the authors did not consider them to be major? This Introduction might (if corrected) be appropriate for a popular science article in a newspaper but certainly not for CARBON.

References are, by definition, items to which a reader may need to refer in order to understand what the authors are doing, and the context in which their research should be placed. Surely there is no need to list standard texts and reference books in References, and if the authors feel they are really necessary there should be some indication of where in the book the referenced information can be found. Many times I ask authors if they expect their readers to read the complete book in order to find the information needed?

Letters-to-the-Editor are necessarily short and should contain no more than 10–12 references. I sometimes see references that give the publication details and then say “and

references therein”. Such statements are unnecessary. Intelligent readers should (one hopes) know that further references can, if necessary, be found in the papers that are cited. For a Letter-to-the Editor cite no more than a dozen of the most important references. I have seen Letters submitted where the space occupied by references is more than that occupied by the main text, something we sometimes refer to as “the tail wagging the dog”!

Perhaps I could ask those who read this editorial a rhetorical question. When did you last fully read the Introduction to a scientific paper in which you were interested? I suspect the answer would be “months ago” for most of you. In my experience people first read the Abstract, then the Conclusions, and if there is something of real interest they “dig into” the Results and Discussion sections. Many journals print what are considered the less important sections of a paper, and the References, in a smaller font. Perhaps it is the Introduction that most often deserves this treatment?

Peter A. Thrower
Editor-in-chief, CARBON

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