

On the Existence of Nonfunctional Materials

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On the existence of non-functional materials

How many times did you see the phrase “functional materials”, or some slight modification of it, in the section of the scientific literature that you browsed last week? Searching for “functional AND materials” on Web of Science renders over 112,000 hits, 13,900 of which were published during 2017 and so far, 6 300 published 2018. Before 1990 there are 1-10 hits per year, in 1990 there were 63, which then increased to 384 hits 1991. Since then the trend points to a steep increase in scientific output on “functional materials” (Fig. 1).

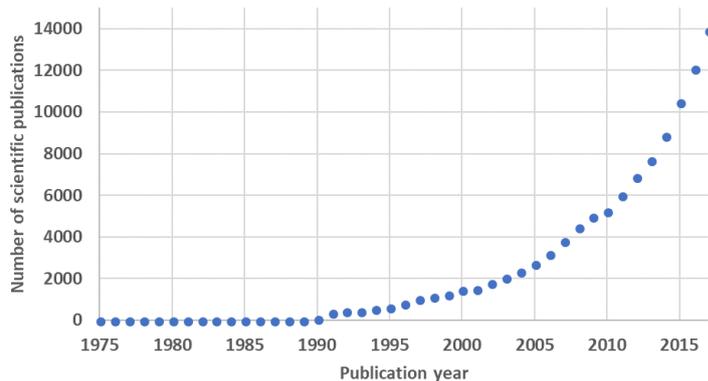


Figure 1. Number of hits for “functional AND materials” in Web of Science June 20, 2018 for scientific publications published 1975-2017. Note that the number of hits for 1975-1989 is between 1 and 10 per year, 1990 shows 63 hits while 1991 shows 384 hits.

“Functional materials” however, is a non-functional phrase: I challenge you to find a single material without any function at all! As materials chemists we know that all materials have properties such as electrical resistivity, hardness, transparency, and thermal conductivity: all of these we can measure, with a varying degree of difficulty. Therefore, all materials have some sort of function to them. It might not always be a function that we think is particularly useful, or the function that we sought for the particular application we might have had in mind, but the material can always be used for something. All materials are, therefore, functional materials.

Knowing this, why do we (myself included) keep using the phrase “functional materials”? Do we use it in grant applications to convince reviewers that this research will for sure lead to something with a function and is therefore a proposal worth funding? Do we use it in our papers, where we report our new findings, to convince our peers that we are not wasting our time on useless “non-functional” materials? Or, are we just throwing in a buzzword that we have heard so many times that it just comes naturally, without actually considering what it means? For me it is the latter.

Some years ago, you could read in my short summary on websites such as LinkedIn and Research Gate that I worked with CVD for “functional materials” such as SiC, BN, B_xC and amorphous carbon. And, yes, all these materials are functional materials – they are packed with functions. They are all semiconductors, some better than others, and this was the main motivation for me to work with them. But the properties, or functions, of SiC and B_xC also include high hardness, and wear resistance. The sp²-hybridized forms of BN and amorphous carbon, that I worked on, have low hardness and, more importantly, low friction. SiC and amorphous carbon are also biocompatible. I

studied the electronic properties of the materials but still liked to use the phrase “functional materials”. I think, and hope, that I never used “multifunctional materials”.

For some time now, I have removed “functional materials” from all of my summaries because I reflected on what the phrase meant. I suggest that we all give some more thought to the words that we use to describe the materials we report, especially when we add some phrases that we have heard several times and sounds good to add to the text. *Nanoscale innovative green functional materials!!* Are the materials functional – of course they are (see above), are they green – not just in their color but to all, or at least most of, the environmentally friendly values today associated with green, are they innovative – to the point that you could actually consider patenting the material, does the structure of the materials on a small size scale provide unique properties or is the structure just a consequence of your new synthesis method?? In the time we live in, we, as the scientific community, have the responsibility to uphold a standard in the scientific texts we produce to use a language free from empty, meaningless buzz phrases just to make our work sound more fantastic than it already is.

When we as scientists are seeking new knowledge and new truths in our research, why do we describe the materials we are reporting on as unique in the sense that they have a function, or are of a certain size? When we know that all materials have a function and a structure also at very small length scales! Or, would you use the phrase “atom-based material” to describe a material? If your answer is yes, then you are sadly not alone.

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