Lab on a Chip

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EDITORIAL

Riding the waves

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A little more than 10 years ago Andreas Manz and Harp Minhas launched the Lab on a Chip journal. Their adventurous initiative has developed into a very successful and high-ranked journal, now established as THE reference journal for lab on chip research, and clearly they, and we, all may be very proud of this achievement!

I remember that in the early days the exact meaning of the term "Lab on a Chip" (LOC) had to be explained countless times, because many authors and probably even the editors weren't quite sure what it meant. Now, 150 issues and over 3000 articles later, most researchers have a pretty good idea of what is meant by "LOC" and, to be honest, all these publications have contributed enormously to the meaning of LOC, even more so, they have shaped the definition of LOC. The topics that we believe fall under the term Lab on a Chip are subject to change over time, however, and the field of LOC is continuously fed by new ideas and technologies that open up new opportunities, both in terms of applications as well new scientific discoveries. Let's take a look what has changed during those 150 issues of Lab on a Chip. The first thing we notice is that the field of *capillary electrophoresis* on chip, at the very origin of Micro Total Analysis Systems and LOC as proposed by Manz and Harrison[1] and in 2002 good for some 25% of all publications in LOC has been decimated to a mere 5% in 2011. This area has clearly matured, and the topic now finds its way in specialized journals like Analytical Chemistry and Electrophoresis, whilst the first commercial products have also emerged. A second important development has been the advent of *cells on chips*, which are present in up to 50% of all articles published in 2012 so far. Striking also is the high interest in *microdroplets* on chips. Although the share of publications dealing with microdroplets remains relatively limited (some 13% in 2012), 5 out of the 10 most cited papers in LOC are about this topic. Another interesting finding is that while in 2002 only 15% of all LOC publications had the word *application* as a keyword, this share has risen to around 30% today, indicating that real applications of LOC systems and devices are now emerging. This fact is strongly backed by a recent market report on MEMS devices by Yole,[2] stating that today microfluidics devices represent little over 10% of the worldwide MEMS market (totalling 12 B$ in 2012), while this percentage is expected to grow to around 20% (and thus the largest segment) of the MEMS market over the next 5 years (projected at 21 B$ in 2017).

In order to keep the LOC journal alive and kicking, and as a consequence of mature topics and applications being transferred to dedicated journals, it is important to continuously explore new micro/nano (fluidic) technologies, and investigate the opportunities for applications and science that they offer. In particular, in my view, we have a "moral" obligation to investigate how our LOC community can help in solving the societal "Grand Challenges," such as sustainable development, energy and water. Obviously, at this moment it seems rather unclear how LOC could help for some of these application areas, and some out-of-the-box thinking is definitely necessary here. I will give a few examples. For water, for example, study of membrane filtration mechanisms using micro/nanofluidic setups may yield new and unexpected

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insights, as indicated by the recent work on ion concentration polarization (ICP) by Han *et al.*[3] In a similar area, some researchers have recently demonstrated that electrical energy can be harvested from the mixing of salt and sweet water in what is called a "blue energy" initiative.[4] Study of this system using microdevices may also lead to further optimization of membrane material properties and operating conditions. Finally, the option to directly convert hydraulic power into electrical energy using streaming potential related principles holds interesting promise, which may crystallize after careful experimentation using Lab on a Chip systems and micro/nanofluidics, but apart from these relevant application areas we should also continuously search for new research topics. If we consider the term Lab on a Chip in its most literal form, it means: a laboratory, an experimentation space, on a chip, preferably using micro/nanofluidics technologies. In such a small laboratory both material ("matter") and information can be manipulated on a small scale, and the definition of Lab on a Chip has become much wider than the one most people used back in 2001, where most of the emphasis was laid on chemical analysis. For instance, one so far poorly explored topic using microfluidics is the study of emerging behavior of complex systems. With the abundant availability of ICT to control deterministic systems, the (lack of) understanding and modeling of the dynamic behavior of complex systems becomes more and more critical. Lab on a Chip platforms may prove to be extremely useful to study and unravel the stability of such complex systems. Here, we may think of collective behavior of cell clusters, tissues *etc.*, but also developments towards synthetic living cells. Another rapidly growing research area is optofluidics, where the combination of exciting micro/nano optical techniques with micro/nanofluidics is expected to create new research avenues. But most probably, the next "big thing" for LOC is something we do not know yet. In that sense the LOC community is very much like a group of surfers that after several successful waverides patiently looks for that next, new and better-than-ever wave to develop. We LOC-researchers should all be attentive and open-minded, ready to create and ride the next wave!

References

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