Electrochemical nanoreactors and nanomotors for potential biomedical applications

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One of the aspirations of nanotechnology is to become true the long-awaited development of nanomachines which can autonomously move and perform different tasks from sensing to repairing and thus to emulate the complex functionalities of biological systems. Such achievement is expected to have a revolutionary impact in fields such as medicine. Under this context, the engineering of artificial self-propelled micro/nanomachines with multitasking capabilities has become a research line of growing interest since the pioneering studies at the beginning of this millennium.
These self-propelled micro/nanomachines generate local physicochemical gradients to drive their own motion, which is harnessed to perform multi-tasking activities in different locations. Self-propulsion generated by gradients from local electrochemical reactions is a very interesting strategy for autonomous motion. Although there have been many proofs of concept of chemical machines performing different activities, the progress on the comprehension of the physicochemical fundamentals behind the self-generated actuation has been more moderate. In many cases, the precise motion mechanism is still not unambiguously identified, and the key physicochemical parameters are not well-characterized. A complete and deep understanding of such issues would help to improve the control levels for applications and to better assess perspectives and challenges of these self-propelled machines. In this presentation, we will review a combined set of techniques that we have implemented to study chemically propelled micro/nanomotors using pumps as the immobilized motor counterparts (Fig. 1). These techniques have turned out to be very useful for mapping chemical reactions and for extracting physicochemical parameters (e.g. electric fields, fluid flows) and thus to achieve a more complete characterization of the mechanisms driving fluid motion [1-3]. Moreover, the chemical reactions in these motors can not only be used to produce the self-propulsion but also to generate reactive products that can in turn chemically modify the immediate environment on the fly. In this context, we will introduce some promising active micro/nanomachines that could have potential impact on biomedicine.

References

[1] M.J. Esplandiu, A. Afshar Farniya, A. Bachtold, ACS Nano; (2015) 9, 11234.
[2] K. Zhang, J. Fraxedas, B. Sepulveda, M.J. Esplandiu, ACS App. Mater. Interfaces, (2017) 9,44948.
[3] M.J. Esplandiu, K. Zhang, J. Fraxedas, B. Sepulveda, D. Reguera, Acc. Chem. Res., (2018) 51, 1921.

Figures

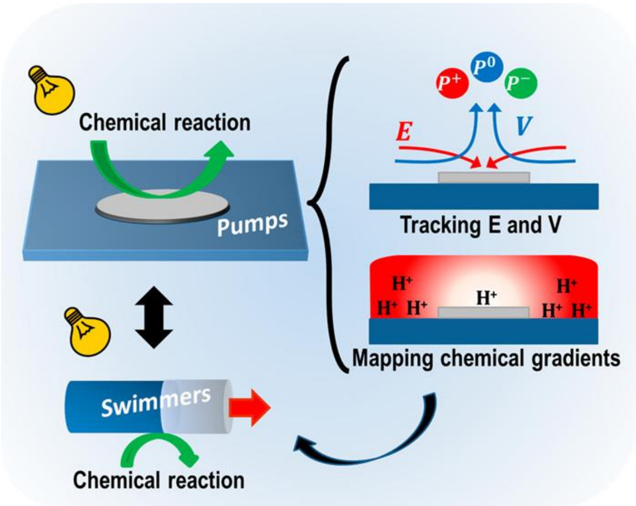

Figure 1. Understanding chemically propelled motors using pumps as the immobilized motors counterparts.