Magnetic and chemical propulsion of mesoporous nanorods as nanomotors

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The research in nanomotors and nanomachines has attracted increasing interests during the last years due to the applicability of these kinds of structures in different fields (biomedicine, energy, catalysis, nanoengineering). In this line, the synthesis of new micro and nano-structures which could be propelled by means of different actuation forces is of great interest in the nanomotors field. In our laboratory, a new methodology has been developed to electrochemically grow mesoporous metallic nanorods (NRs) [1, 2]. In the present work we study the movement of two types of magnetic mesoporous NRs (CoNi and CoNi@Pt) under two actuation forces: oscillating magnetic fields at different frequencies and field strenghts, and chemical forces generated by a gas during a chemical reaction.

Both kind of synthesised mesoporous NRs respond to rotatory magnetic fields giving to a continuous rolling movement and in the direction defined by the field (Figure 1a). When borohydride is present in the aqueous solution, the CoNi@Pt NRs show a stepped rolling movement. It can be explained by the hydrogen generated during NRs catalyzed borohydride decomposition. The massive exit of the H_2 gas entrapped into the nanorods'pores togheter with the magnetic field propel de NRs in a stepped trajectory (Figure 1b). CoNi NRs are poor catalysts to borohydride decomposition and only the magnetic force significantly affects their displacement.

References

[1] A. Serrà, E. Gómez, E. Vallés, Electrochimica Acta, 174 (2015) 630.
[2] A. Serrà, N. Gimeno, E. Gómez, M. Mora, M. Ll. Sagristá, E. Vallés, Advanced Functional Materials, 26 (2016) 6601.

Figure

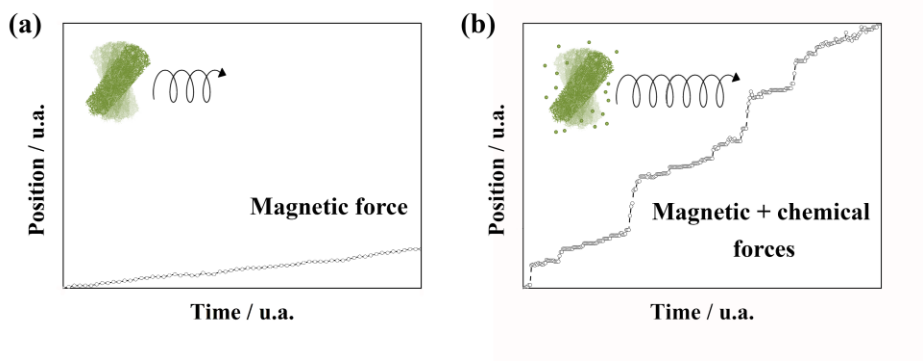

Figure 1: Trajectory of CoNi@Pt NRs in (a) aqueous media and (b) sodium borohydride solution.