Autonomous catalytic motion of carbon nanotubes

A. Afshar Farniya[1], M.Esplandiu[1], P. Jimenez[2], A. Benito[2], W. Maser[2], P. Ortiz[3], A. Llobera[3] and A.Bachtold[1]

[1]Centre d'Investigació en Nanociència i Nanotecnologia CIN2 (ICN-CSIC), Campus UAB Bellaterra, Barcelona, Spain
[2]Instituto de Carboquimica de Zaragoza (CSIC), Departamento de Nanotecnología, Zaragoza, Spain
[3]Centro Nacional de Microelectrónica (CSIC), Campus UAB Bellaterra, Barcelona, Spain

Aafshar@icn.cat

Biomotors (or motor proteins) have attracted a lot of attention as nanomotors, since they can perform various tasks such as cell division and intracellular transport [1]. One problem of biomotors is that they degrade rapidly outside the physiology of the cell. Therefore, researchers have tried to look for alternatives. Applying man-made catalytic nanomotors is an appealing prospect. Catalytic motors can convert chemical fuel such as H_2O_2 molecules into autonomous motion and perform tasks, such as the transportation of cargo [2].

Catalytic motors typically consist of the assembly in series of two rods made of different materials (for instance, Au and Pt). The precise chemomechanical transduction mechanism is still the subject of current investigations. A possible mechanism is that the oxidation of H_2O_2 occurs preferentially on the Pt rod while the reduction of H_2O_2 and O_2 takes place on the Au rod [3]. These simultaneous reactions cause the electrons to be transferred from the Pt to the Au end. The electron flux is accompanied by the motion of the protons that are surrounding the rods in the solution. This proton flux pushes against the fluid, leading to the directional motion of the nanoscale motor. Interestingly, the direction of the motion can be controlled using solution with H_2O_2 gradient. The motor goes towards the concentration maximum [4].

We propose to develop catalytic motors based on single carbon nanotubes (Fig 1). Au will be patterned at one end of the carbon nanotube and Pt on the other one. One motivation is that the motion may be more efficient. Indeed, the friction from the surrounding liquid may be reduced due to size reduction. In addition, the speed may be enhanced, since (a) nanotubes can conduct electrons without any resistance over long distances and (b) conducting electrons are located at the tube surface, which allows for a larger interaction with protons.

These catalytic nanotube motors may be used for sorting applications. It may sort metal and semiconducting nanotubes, since semiconducting nanotubes are expected to remain more immobile (as they carry much lower electron currents).

References

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Figures

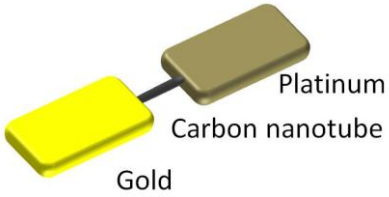

Figure 1 Carbon nanotube –based catalytic motor