Versatile Micromotors for Photocatalytic Environmental Remediation

Huaijuan Zhou
Zdenek Sofer
University of Chemistry and Technology Prague,
Technická 5, Dejvice, 166 28 Praha 6, Czech Republic
zhouu@vscht.cz

Environmental degradation issue is a global concern. Great efforts have been made to develop efficient and green approaches for wastewater treatment. Self-propelled nano/microrobots are the forefront of nanotechnology, holding great promise for environmental remediation. Visible light driven semiconductor photocatalyst would be the great catalyst to power such micromachines for environmental remediation. $BiVO_4$ has attracted researchers' great interest. However, its drawbacks such as significant recombination of photogenerated electron–hole pairs, poor electrical conductivity and slow hole transfer kinetics limit its applications. To enhance the photocatalytic efficiency, we elaborately develops light-responsive tubular micromotors with smart material design strategy: BiVO4 is robust visible light absorber; ZnO nanorod arrays act as electron transfer channel; reduced graphene oxide (rGO) films function as electron acceptor; and Co-Pi serves as hole acceptor and catalytic site. Herein, we established novel tubular Co-Pi/$BiVO_4$/ZnO/rGO micromotors, studied the comprehensive performance of micromotors in the polluted water with three types of contaminant models (i.e. dye, explosive and bacteria model); and integrated abundant micromotors in 3DP-motor and demonstrate the pilot-scale test in artificial 5×5m^2 pool for environmental remediation, as illustrated in Figure 1. This work is sponsored by the Marie Skłodowska-Curie Actions (MSCA) Individual Fellowship.

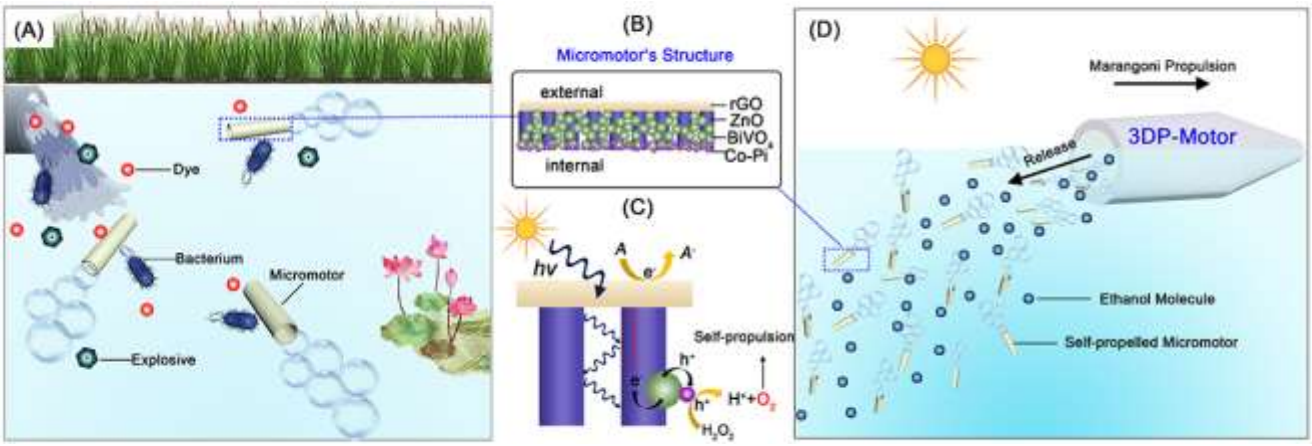

Figure 1: Schematic illustration of (A) versatile micromotors dynamically degrading dyes and explosives and killing bacteria in contaminated water, (B) structure of the designed micromotor, (C) design strategy of Co-Pi/BiVO4/ZnO/rGO: (i) increased light absorption and charge generation in both BiVO4 and ZnO through light trapping effect of the nanorods, (ii) electron injection into ZnO nanorods followed by prompt electron transport along ZnO nanorods, (iii) electron collection and storage in rGO for reduction reaction and (iv) hole transfer to Co-Pi for efficient water oxidation to generate oxygen bubbles for self-propulsion of micromotor, (D) 3D-printed millimeter-scale motor releasing micromotors and ethanol molecules.