Nanorods with Biocatalytically Induced Self-Electrophoresis

Nanorods with motion enhanced through biocatalytically induced self-electrophoresis are described. To obtain such nanorods, the polymer half of polypyrrole-gold (PPy-Au) nanorods is decorated with horseradish peroxidase (HRP) and their metal half with cytochrome (Cytc). If such nanorods are suspended in enzymatically generated mixtures of $O_2(-)$ and $H_2O_2$, the immobilized Cytc is reduced by $O_2(-)$, and the immobilized HRP is oxidized by $H_2O_2$. As both hemeproteins are capable of direct electron transfer to/from solid substrates, the oxidized HRP is subsequently reduced with electrons received, through the nanorod, from the reduced Cytc. The combined processes cause species from the electrical double layer of the nanorods to move from one end of the nanorod to the other, which powers the motion of the nanorods in the opposite direction. The diffusive motion of the hemeprotein-modified nanorods is characterized by a diffusion coefficient 30% larger in the presence of $O_2(-)$ and $H_2O_2$ than in their absence. Unmodified nanorods do not show such behavior.