Manganese dioxide shows potential in micromotors

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Manganese dioxide could make the preparation of micromotors increasingly cost-effective, opening up new avenues for their use, according to a new study from the University of Eastern Finland.

Synthetic micromotors are tiny particles with dimensions less than the diameter of a human hair. Micromotors can undergo an autonomous motion in liquid environments, which can be driven by various means such as a chemical fuel, ultrasound, light or magnetic field. Fuel-driven micromotors are often catalytic in nature, which causes the transformation of a chemical fuel into reaction products that lead to a self-propulsion of the particles. Micromotors may find use in the future, for example, in targeted drug delivery, specific catalysis or chemical sensing of harmful substances.

Platinum is the most widely explored catalytic material for the preparation of micromotors. It efficiently decomposes hydrogen peroxide into oxygen gas and water. However, platinum is an extremely rare chemical element and also suffers from serious limitations, such as drastically reduced catalytic efficiency in salt-rich environments and complete inactivation in the presence of sulphur containing compounds. Manganese dioxide is an alternate inorganic material that can decompose hydrogen peroxide similar to platinum. Manganese dioxide is also cheap and available in large quantities. Thus, it is a very potential new material for the preparation of catalytic micromotors, but has been scarcely explored to date.

In the study, a variety of manganese dioxide based micromotors were synthesized and characterized in terms of their motion behaviour in solution. Based on the results, the prepared micromotors exhibited a remarkable propulsion efficiency even in the presence of very low fuel concentrations. To demonstrate their potential for practical applications, the micromotors were used for the removal of organic dyes from water. The dye removal process was based on a unique effect that combined catalytic degradation and adsorptive bubble separation processes. The dye removal efficiency was over 90 percent in just one hour of reaction time without external mixing. In addition, manganese dioxide was used as a simple means for protecting the conventional platinum-based micromotors from sulphur toxicity.

Self-propelling micromotors may offer new opportunities to deliver drugs precisely to the tumour, with minimal adverse effects to the healthy tissues. Micromotors also possess an enormous potential to convert water pollutants into non-toxic or less-toxic products, even at difficult to reach areas and remote field locations, where external means of mixing to speed up the processes are not viable. Manganese dioxide micromotors, which can undergo a fast motion for a sufficient period of time in the presence of a low concentration of hydrogen peroxide, are expected to find diverse applications for active drug delivery and water remediation.

More information: Tam Do Minh et al. Protection of Platinum-Based Micromotors from Thiol Toxicity by Using Manganese Oxide, *Chemistry - A European Journal* (2017). DOI: 10.1002/chem.201700788

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