Research Highlights

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A Low-cost, Safe and High-performance Iron Oxide Photocatalyst

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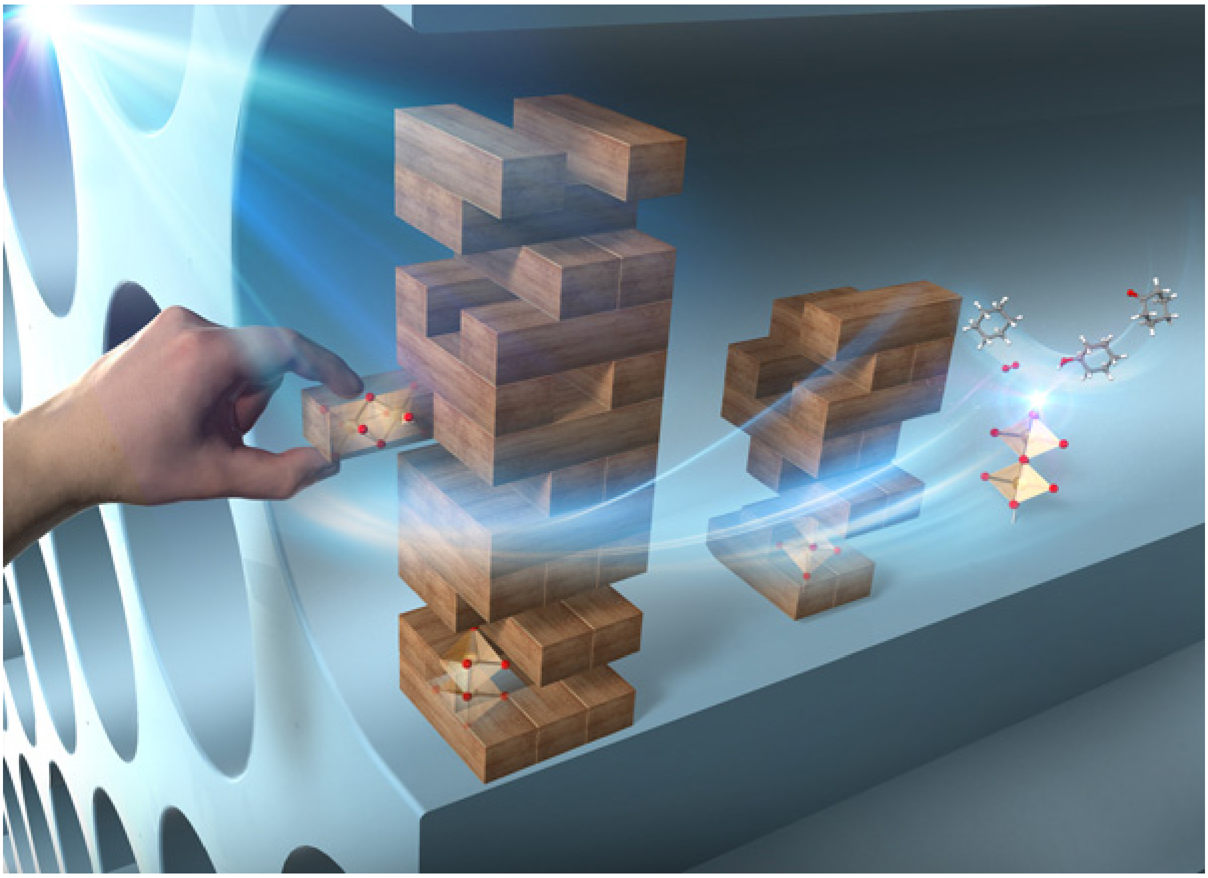
A team at MANA has devised a technique for boosting the performance of iron oxide photocatalysts, which could lead to low-cost, non-toxic and environment-friendly alternatives to current materials, as well as new uses, such as photocatalytic applications in living bodies.



Photocatalysts like titanium dioxide (TiO_2), when irradiated with sunlight or indoor light, have the ability to oxidize organic molecules. This makes them useful in a variety of environmental and energy-related applications, such as air cleaners, antibacterial tiles, self-cleaning surfaces, air and water purification systems, sterilization, hydrogen evolution, and photoelectrochemical conversion.

They are also expected to be used to synthesize organic chemicals such as nylon precursor KA-oil, but because of their low performance, they have to be modified with expensive and toxic materials to make them usable.

Iron oxides are non-toxic and relatively low-cost photocatalysts. But their activity is low because of too-fast recombination of photo-generated electrons and holes that attack organic molecules.

The MANA team designed an iron oxide material exhibiting an unprecedentedly high photocatalytic performance by immobilizing ferric oxide nanoparticles on the walls of a scaffold made of mesoporous silica. These nanoparticles are partially etched to stably form condensed ferric dimeric molecules, which are otherwise very unstable. The result was a new photocatalyst with retarded electron hole recombination due to its structure, as well as activity for KA-oil synthesis via oxidation of cyclohexane that is much higher than TiO_2.

The material's performance is higher than its predecessors, but more improvement is needed for practical use by optimizing synthetic conditions and reaction conditions, such as ferric dimer loading, catalyst amounts and light intensity. The team also plans to investigate other related photocatalysts for oxidizing a range of organic compounds for chemical synthesis and environmental purification.

This research was carried out by Yusuke Ide (Acting Group Leader of Mesoscale Materials Chemistry Group, MANA, NIMS) and his collaborators.

Reference

"Condensed ferric dimers for green photocatalytic synthesis of nylon precursors"
Yusuke Ide, Satoshi Tominaka, Yumi Yoneno, Kenji Komaguchi, Toshiaki Takei, Hidechika Nishida, Nao Tsunoji, Akihiko Machida and Tsuneji Sano
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