

SCIENCE

IISER Pune team synthesises photocatalyst to degrade organic pollutants



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The highly unstable perovskite mineral was converted into a robust form capable of decomposing toxic organic pollutants commonly present in water

Researchers at the Indian Institute of Science Education and Research (IISER) Pune have successfully converted the highly unstable perovskite into a highly stable photocatalyst capable of decomposing toxic organic pollutants commonly present in water. The catalyst that becomes active when exposed to sunlight was synthesised by encapsulating nanocrystals of organic-inorganic perovskite inside a metal-organic framework (MOF).

The team led by Sujit K. Ghosh from the Department of Chemistry at IISER Pune utilised the hydrophobic nature of the MOF material to render greater chemical stability to perovskite nanocrystals that form inside the MOF cavities. The perovskite-MOF composites displayed “outstanding” stability when immersed inside water and alcoholic solvents for as long as 90 days.

Stable composite

The composites remained stable in water even when at boiling temperature for 20 days. While perovskite encapsulated by MOF showed 70% similar photoluminescence intensity before and after heat treatment at the end of 20 days, the photoluminescence intensity of naked perovskite decreased by 95% in just five hours of heat treatment. Likewise, the photoluminescence intensity of the composite remained almost intact even after being exposed to UV light for 20 days.

It is the hydrophobic nature of MOF that renders chemical, heat and photostability to perovskite.

The researchers found less than 1 ppb of lead metal leached from the composite at the end of 90 days of being exposed to different solvents, including water. “It is possible to replace lead metal with other nontoxic elements to make the composite more efficient and much safer to degrade organic pollutants,” says Dr. Ghosh. The results were published in the journal *ACS Applied Nano Materials*.

“This is the first time perovskite-based composite material as a photocatalyst has been used for the degradation of toxic organic pollutants such as antibiotics, dyes etc. It will be a cost-effective method to produce clean water,” says Dr. Ghosh.

The researchers tested the composite’s photocatalytic property to degrade organic pollutants in water. They tested three organic commonly seen pollutants – methyl orange, methyl red and nitorfurazone antibiotic.

Activated by sunlight

“When the composite was exposed to sunlight it was able to degrade the organic pollutants,” says Samraj Mollick from IISER Pune and one of the first authors of the paper. “When exposed to sunlight, the perovskite nanocrystals release electrons into water thus producing hydroxyl radicals. The hydroxyl radicals are highly active species that decomposes the organic pollutants.”

But the rate of degradation of organic pollutants is not high compared with other standard materials. “Compared with other materials, perovskite is inexpensive. It is also possible to scale up its production easily,” says Tarak Nath Mandal, the other first author of the paper.

“This is only a proof-of-concept study. It is possible to increase the degradation rate by using different perovskite and MOF materials,” says Dr. Ghosh.

The researchers were able to recycle the composite thrice and even on the third cycle the composite displayed over 90% degradation capacity.

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