SCIENCE

NIIST's photoluminescent ink shows good photostability

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The ink retains over 70% photoluminescence intensity at the end of one month

Using a novel approach, researchers at the National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Thiruvananthapuram have formulated a fast-drying fluorescent ink that retains over 70%

photoluminescence intensity even at the end of one month. There was 26% drop in emission intensity within one hour of printing using the ink containing the fluorescent dye and further drop of 2% in two hours. But no reduction in emission intensity was seen after three hours.

This has become possible with the team led by Dr. K.P. Surendran from the Materials Science and Technology Division at NIIST encapsulating the fluorescent dye — fluorescein — within double-layered silica nanospheres. Since encasing the dye using a single layer of silica did not completely prevent dye leakage, the researchers used a second layer for encapsulation. The silica nanospheres are 70-80 nanometres in size.

As a result of the double-layered encapsulation, fluorescent dye is largely protected from dispersants, solvents and binders present in the ink. So there is less likelihood of reduction in photoluminescence intensity through dye leakage. Encapsulation of the dye in double-layered silica nanoparticles also prevents cluster formation. The dye used without any encapsulation lacks photostability and the fluorescence completely decays within a couple of hours. The **results were published** in the journal *ACS Omega*.

Fuorescent ink is used for a wide range of applications in domains such as anticounterfeiting, information storage, bioimaging, smart packaging, and nanoelectronics. Retention of photoluminescence for prolonged periods is a major challenge in fluorescent inks.

“Since the fluorescent dye should not come in contact with the solvent present in the ink as this would cause decay in photoluminescence, we encapsulated it in double-layered silica nanoparticles,” says Kanakangi S. Nair from NIIST and first author of the paper. “The fluorescent double-layered silica nanoparticles assemblies were synthesised through a reverse microemulsion technique.”

When dye encapsulated in double-layered nanoparticles was dispersed in the solvent, it shows strong fluorescence. But when the encapsulated dye was formulated into ink, the emission intensity reduced by 10%. “The fluorescence gets slightly reduced but is not significantly affected by other components present in the ink,” says Dr. Surendran.

Quick drying

Another advantage that the team observed is the quick drying of the ink at room temperature. “It dried in less than 20 seconds at room temperature. The formulation of the ink was meticulously designed so as to allow quick drying without using any external drying agents,” Dr. Surendran notes. However, most commercial fluorescent inks are cured using ultraviolet lamps or infrared emitters, or a combination of both.

The dried ink containing the dye is cream in colour under visible light but turns green when exposed to ultraviolet light. When the UV light is cut, the dye immediately regains its original colour (cream).

The team used commercially available dye and is now working to encapsulate NIIST propriety dyes using the same procedure. The propriety dyes have multiple emissions and so will help in increasing the security feature of the ink.

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