IIT MADRAS
Indian Institute of Technology Madras

Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

FLUORESCENCE-SPECIFIC BIOCOMPATIBLE ZINC OXIDE NANOPARTICLES FOR ANTICOUNTERFEITING INK AND ITS REAGENT FREE SYNTHESIS THEREOF

IITM Technology Available for Licensing

PROBLEM STATEMENT

- **Photoluminescence study** is crucial for understanding luminescence properties of materials like ZnO.
- **Control over near band-edge emission** and **deep-level emission** is challenging in single-step synthesis processes.
- **Anti-counterfeiting remains** a significant challenge, necessitating new materials and technologies.
- Various organic and **inorganic samples explored for creating fluorescent ink are mostly toxic**.
- Unsaturated complex organic compounds are biocompatible but not stable or water-resistant.
- Researchers are aiming to synthesize biocompatible and **cost-effective quantum dots (QDs) for fluorescent ink.**
- **ZnO is a biocompatible material** highly fluorescent in UV-A and B light excitation.
- **Fluorescent fiber is used in bank currency**, passports, and stamps for anti-counterfeiting.

TECHNOLOGY CATEGORY/ MARKET

Technology: Fluorescence-specific biocompatible zinc oxide nanoparticles for anticounterfeiting ink and its reagent free synthesis

Category: Micro & Nano Technologies

Industry: Printing, Consumer Goods & Electronics,Pharmaceuticals and Healthcare

Application: Security Inks, Authentication and Verification

Market: The global market size estimated to reach **USD 4.71 billion by 2032,** growing at a CAGR of 4.03% during the forecast period **(2024–2032)**

INTELLECTUAL PROPERTY

IITM IDF Ref. 2761,Patent No: IN 550055

TRL (Technology Readiness Level)

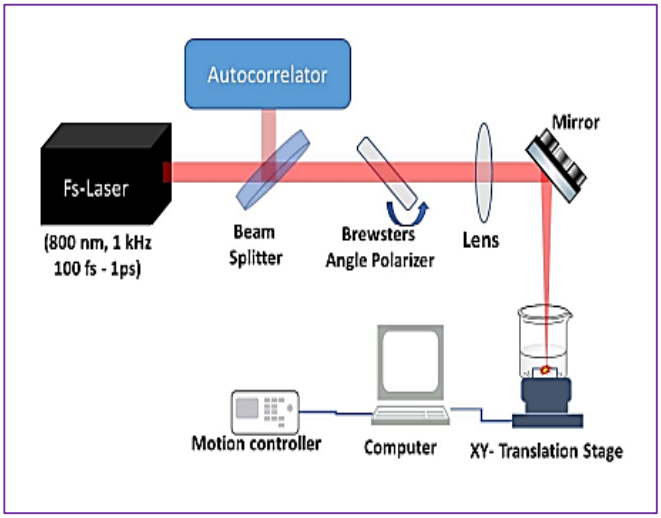
TRL- 3, Experimental proof of concept;

Research Lab

Prof. Sivarama Krishnan &
Prof. Ramachandra Rao M S,
Dept. of Physics

TECHNOLOGY

Fig 1 shows the experimental setup for the pulse width dependent fs- pulsed laser ablation in liquid



Method

1. **ZnO powder is pelletized** and sintered at 700-900°C for 22-26 hours to create strong, unbreakable ZnO pellets.
2. **Sintered ZnO pellets** are immersed in ethanol, and femtosecond laser pulses are focused on them to ablate ZnO surface, and **produce nanoparticles.**
3. The laser operates at 1 kHz repetition rate, with pulse width adjustable between 150-750 fs and **ablation power 0.25-1.5 W, and is raster scanned for 15-25 minutes**.
4. The nanoparticles are ablated, then **centrifuged** at 4500-5500 rpm to ensure uniform particle size distribution, and the **final nanoparticles are collected.**

CONTACT US
Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

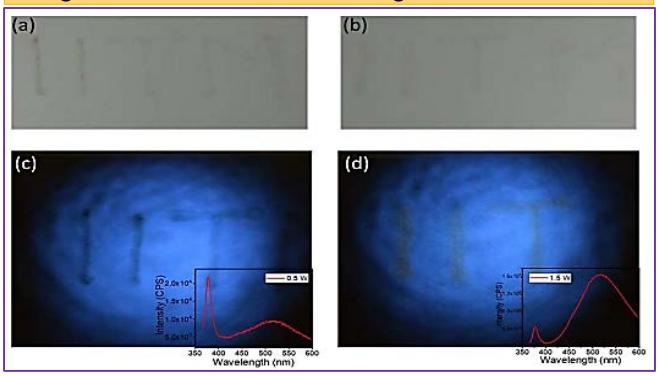
Email: headtto-icsr@icsrpis.iitm.ac.in
tto-mktg@icsrpis.iitm.ac.in
Phone: +91-44-2257 9756/ 9719

IIT MADRAS
Indian Institute of Technology Madras

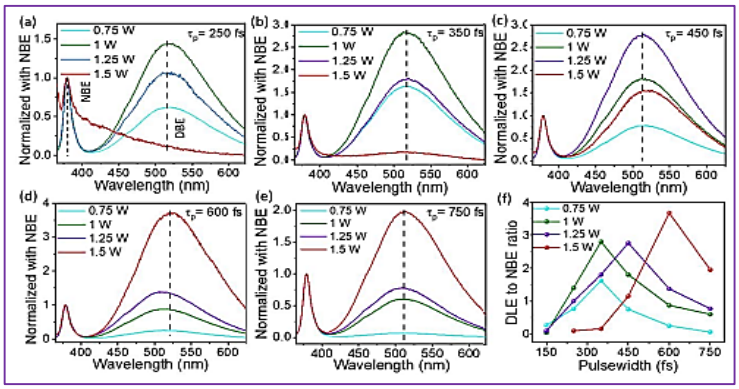
Technology Transfer Office
TTO – IPM Cell

Industrial Consultancy & Sponsored Research (IC&SR)

Panels (a) and (b) show ZnO nanoparticles on white paper in daylight, whereas panels (c) and (d) show their digital images at 325 nm excitation wavelength.



Optical emission PL spectra of ZnO nanoparticles prepared with range of different pulse-widths and ablation power.



Key Features / Value Proposition

ZnO Nanoparticles' Fluorescence-Specific Emission Profile

- Fluorescence emission only under UV excitation in **260-365 nm range**.
- Sharp near band-edge emission at **378 nm**.
- Broad green emission at **520 nm** due to deep level emission (DLE).
- Useful for anti-counterfeiting applications due to UV- excitation.
- Blind to visible wavelengths, i.e. **400-700 nm**

ZnO Nanoparticle Size and Distribution

- Average size: **4-5 nm**, particle size distribution: **2 nm.**
- Smaller sizes and modified surface properties improve fluorescence efficiency and stability .
- Similar size with different fluorescent properties are crucial for anti-counterfeiting inks application.

ZnO Nanoparticles' Tunable Emission Profile

- Photoluminescence emission tunable between violet to green.
- Color adjustment based on DLE to NBE emission ratio.
- Enhances ink versatility for various security applications.

Reagent-Free and One-Step Synthesis of ZnO Nanoparticles

- Utilizes femtosecond laser ablation in liquid (fs-PLAL) method for synthesis.
- Process includes pelletizing ZnO powder, sintering at **700-900°C for 22-26 hours,** laser ablation in a solvent, and centrifuging for uniform particle size distribution.
- This reagent-free method simplifies production, reduces costs, and minimizes environmental impact.

ZnO Nanoparticles' Deep Level Emission Control (Green emission)

- Adjust pulse duration and ablation power during synthesis.
- Enhance DLE emission by varying laser ablation power from **0.5 W to 1.5 W.**
- Maintain pulse duration between **500-600 fs.**
- Fine-tune green emission for anti-counterfeiting ink fluorescence characteristics.

ZnO Nanoparticles as Fluorescent Anti-Counterfeiting Ink

- **No additional binders or additives needed. Simple**, cost-effective process.
- **Ideal for currency, documents,** products. Offers hidden security under UV light.

CONTACT US

Dr. Dara Ajay, Head TTO
Technology Transfer Office,
IPM Cell- IC&SR, IIT Madras

IITM TTO Website:
https://ipm.icsr.in/ipm/

Email: headtto-icsr@icsrpis.iitm.ac.in
tto-mktg@icsrpis.iitm.ac.in

Phone: +91-44-2257 9756/ 9719