**Evolution of ZnS:Mn Nanoparticle Morphology During Microwave-Assisted Hydrothermal Synthesis**

John Doe1, Jane Smith1, Robert Brown1, Emily White2

*1 Department of Materials Science, University of Lasers*

*2Institute of Nanotechnology, University of Vision Science*

Doped ZnS materials have garnered significant attention due to their excellent optical and electronic properties, making them ideal for applications in photoluminescent and electroluminescent devices, solar cells, and display technologies [1]. The morphology of ZnS nanoparticles, particularly the formation of hierarchical structures like nanoflowers, is highly sensitive to synthesis conditions. Real-time monitoring of reaction kinetics during synthesis is crucial for controlling particle morphology and optimizing material properties.

Microwave-assisted hydrothermal (MWHT) synthesis offers several advantages over conventional hydrothermal methods, including rapid reaction rates, uniform heating, and precise control over reaction parameters [2]. This study investigates the impact of different precursors (zinc nitrate hexahydrate, manganese acetate tetrahydrate, and thiourea) and surfactants (cetyltrimethylammonium bromide and polyethylene glycol) on the structural, morphological, and optical characteristics of Mn-doped ZnS nanoparticles. The MWHT method enabled in situ sampling, providing valuable insight into the reaction dynamics.

X-ray diffraction (XRD) analysis confirmed the formation of cubic ZnS with crystallite sizes in the range of 4–6 nm. Additionally, transient ZnO phase formation was observed, correlating with the growth of flower-like ZnS structures as revealed by scanning transmission electron microscopy (STEM) [3]. Photoluminescence (PL) measurements indicated a progressive increase in PL intensity, with a prominent band at 2.10 eV corresponding to the​ transition of Mn²⁺ ions. These findings contribute to a deeper understanding of ZnS:Mn nanoparticle evolution during MWHT synthesis, paving the way for improved design of luminescent materials.

**Acknowledgment:**

This research was supported by the National Science Foundation under Grant No. 1234567. The authors also acknowledge the Advanced Materials Research Center for access to characterization facilities.

**References:**
[1] A. B. Johnson et al., J. Appl. Phys. **125**, 145102 (2023).
[2] C. D. Lee and H. K. Park, J. Mater. Chem. C **10**, 6789 (2022).
[3] R. T. Evans et al., Phys. Rev. B **98**, 075201 (2021).