Controlled Fabrication of Er^{3+}/Yb^{3+} Doped MnF_2 Nanostructures for Bioimaging

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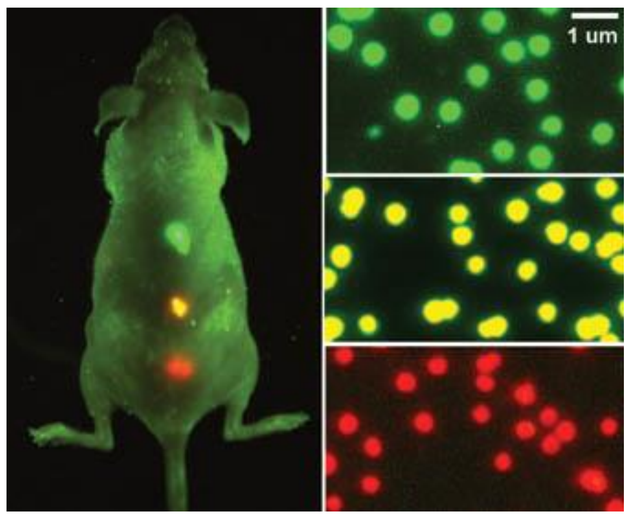
Abstract

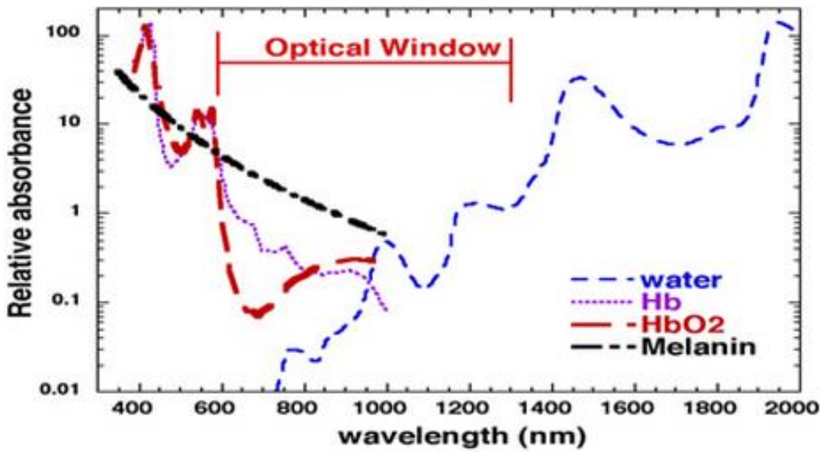
In the present work, we have described a facile synthetic method for the preparation of MnF_2 nanostructures with Er^{3+} and Yb^{3+} ions homogeneously incorporated in the host lattice. Various morphologies, such as nanoparticle, nanocluster and nanolantern, can be obtained with controllable sizes from 200 nm to 1.5 μm. As a result of efficient energy transfer between the dopant Er^{3+} ion and host Mn^{2+} ion, remarkably pure single-band UC emissions were generated in the red spectral region. The achieved red emission is two times stronger than that of $NaYF_4$:Er^{3+}/Yb^{3+} nanocrystals.

Introduction

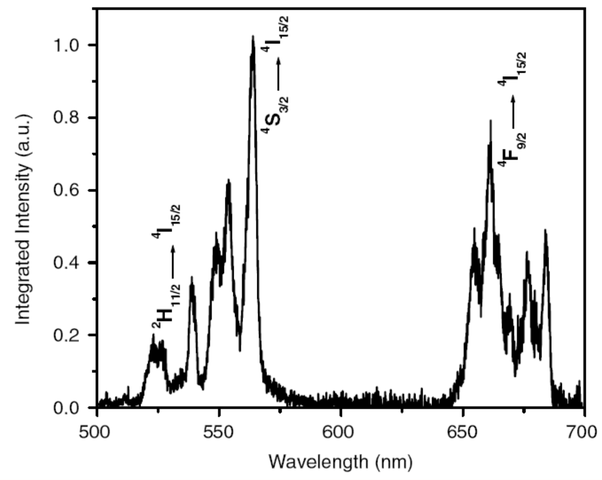
- Biological fluorescence labels



- Biological transmission window



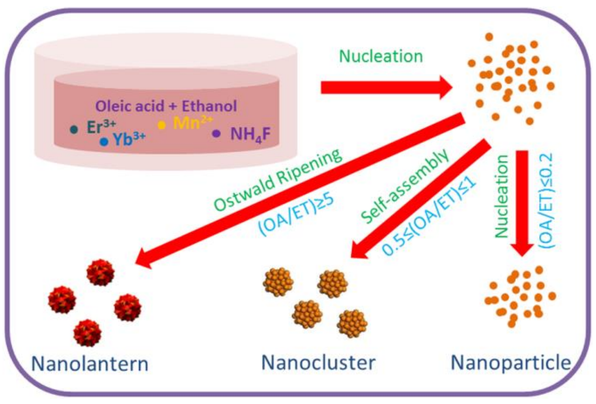
- Upconversion luminescence from Er^{3+} - Yb^{3+}



Purpose Avoiding the green emission and achieving strong and single-band red emission from Er^{3+} - Yb^{3+} couple is essential for the deep tissue imaging of fluorescent labels.

Experimental

- Solvothermal synthesis



✓(1) The ratio between oleic acid (OA) and ethanol (ET):

0 : 24 mL, 4 : 20 mL, 8 : 16 mL,

12 : 12 mL, 16 : 8 mL, 20 : 4 mL,

24 : 0 mL

✓(2) Reaction temperature:

110~200 ℃

- Measurement

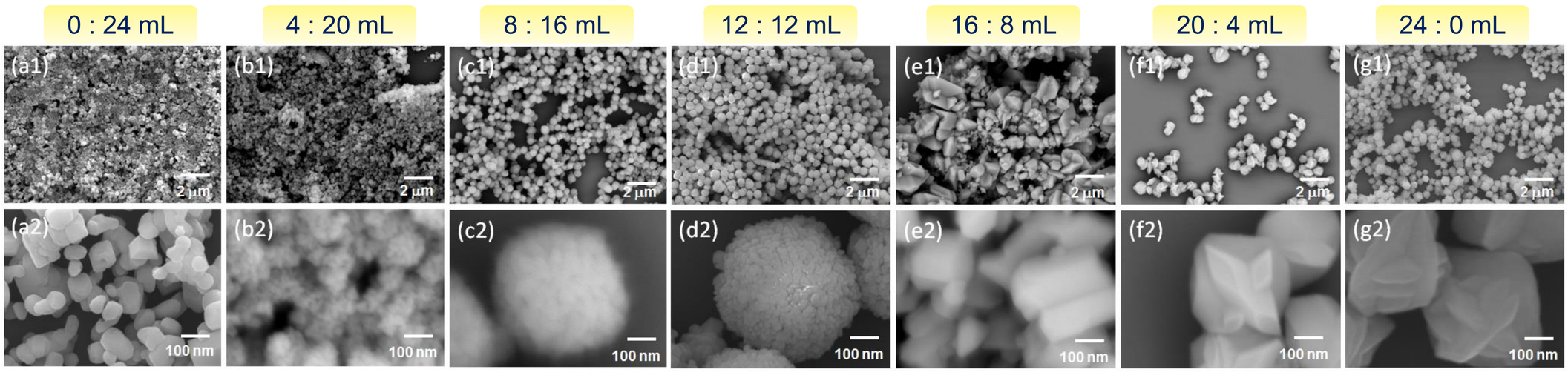
XRD

SEM

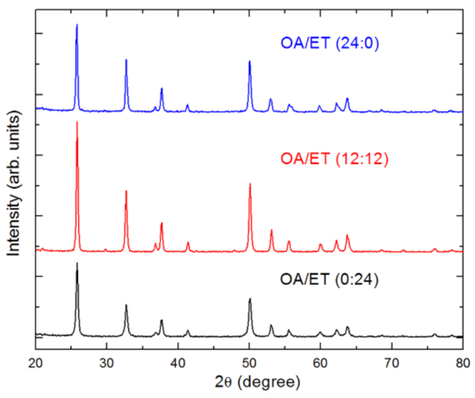
Photoluminescence

Results and Discussion

- Low-resolution and high-resolution SEM images

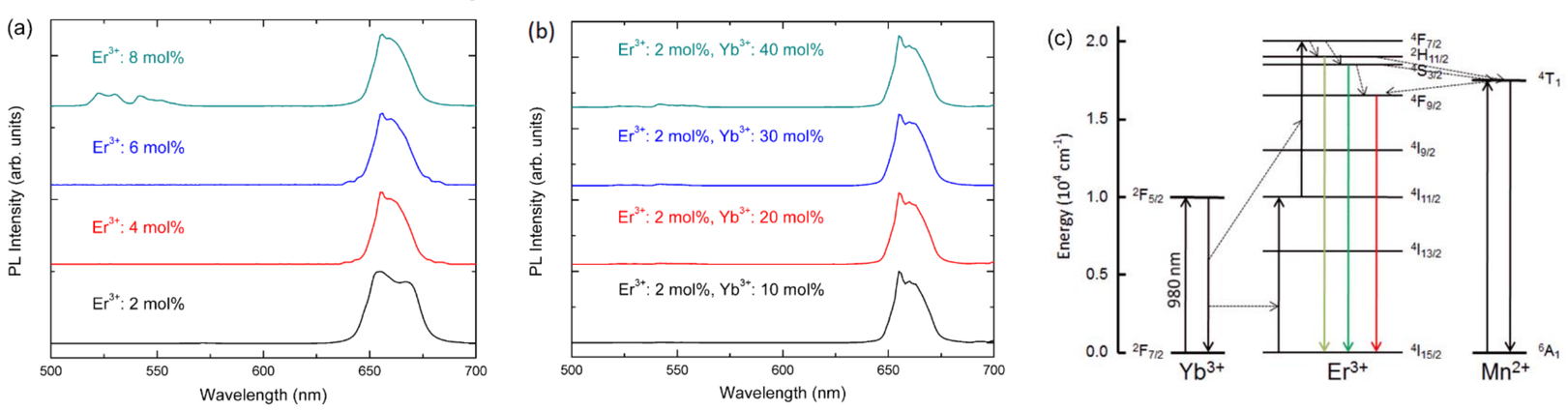


- X-ray diffraction spectra



MnF_2 crystal (JCPDS no. 24-727)

- Photoluminescence spectra



Conclusion

- The morphology of the nanocrystals could be well controlled from nanoparticle to nanocluster and nanolantern.
- The size is tuned from 200 nm to 1.5 μm with the increase of reaction temperature from 110 to 200 ° C.
- Single-band red upconversion emission can be generated in Er^{3+} single and Er^{3+}/Yb^{3+} codoped MnF_2 nanoclusters due to the energy transfer between host Mn^{2+} and dopant Er^{3+} ions.

References Z. Bai, H. Lin, J. Johnson, S. C. Rong Gui, K. Imakita, R. Montazami, M. Fujii, N. Hashemi, Journal of Materials Chemistry C, 2, 1736 (2014).