Europium-doped Cerium Oxide Nanotubes as a potential probe for bioimaging and optical sensors

Leonardo Ojeda Hernandez, Kayla Brownell, Joseph Chouinard and Jeffery L. Coffer, Ph.D.
Texas Christian University
Department of Chemistry and Biochemistry

I. Introduction

The development of cerium oxide (CeO_2) nanomaterials is rapidly advancing, driven by their wide range of applications in catalytic converters, solid oxide fuel cells, and biological sensors. Considering this, doping CeO_2 with rare earth elements such as Europium (Eu^{3+}) not only enhances its catalytic properties but also adds visible fluorescence to the list[(1)]. To explore the variability of this effect, Eu^{3+} doped CeO_2 nanotubes were synthesized and carefully analyzed by varying the Eu^{3+} concentration to investigate their optical properties, crystallinity, and morphology. Current research is focused on evaluating the potential of these doped CeO_2 nanotubes as probes for bioimaging and optical sensors.

II. Experimental

A. Synthesis of the $EuCeO_2$ Nanotubes

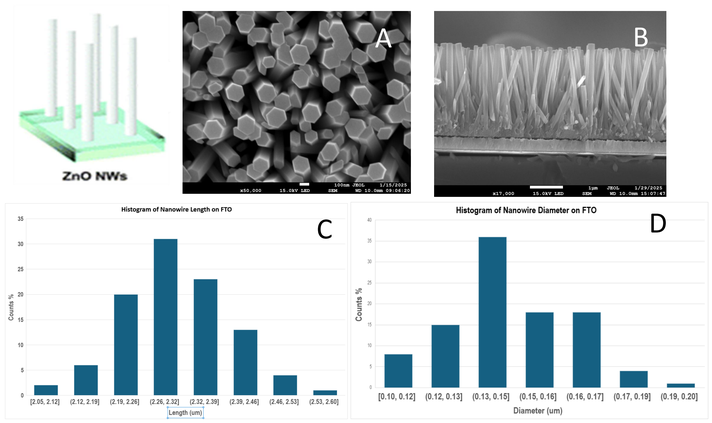

Fig 1. (A) SEM image of ZnO NWs on fluorine-doped tin oxide (FTO) substrate; scale bar 100 nm (B) SEM image cross-section of ZnO NWs on FTO substrate. Scale bar 1 um (C-D) Histograms refer to length and diameter size. Growth of ZnO NWs at 95◦C.

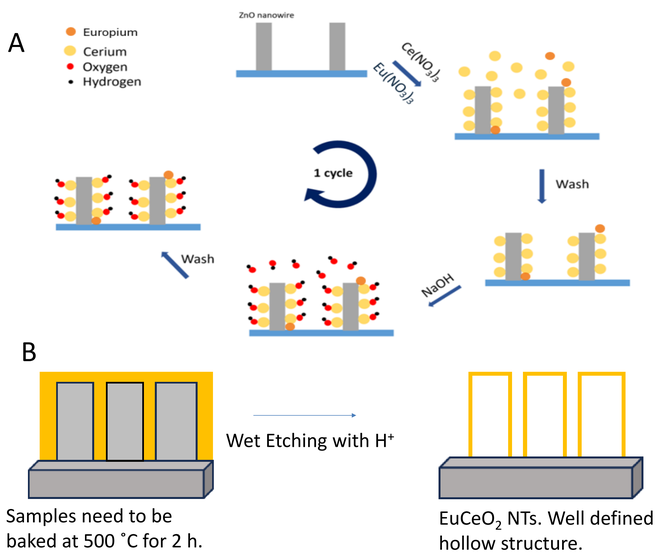

Fig 2. (A) Sketch of the cycling deposition method of the doped $EuCeO_2$ using the spin coater (B) Sketch of the sample before and after etching.

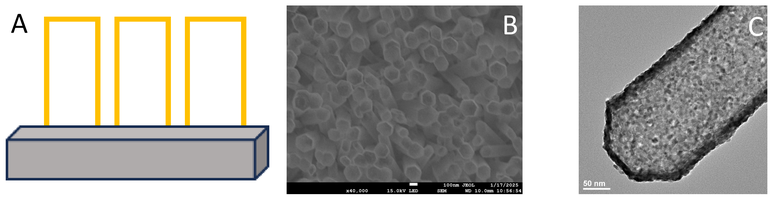

Fig 3. (A) Sketch of the $EuCeO_2$ NTs. (B) SEM image of the EuCeO2 NTs on FTO 5 % EU^{+3}. Scale bar 100 nm (C) TEM image of the $EuCeO_2$ NTs 5 % Eu^{+3}. Scale bar 50 nm

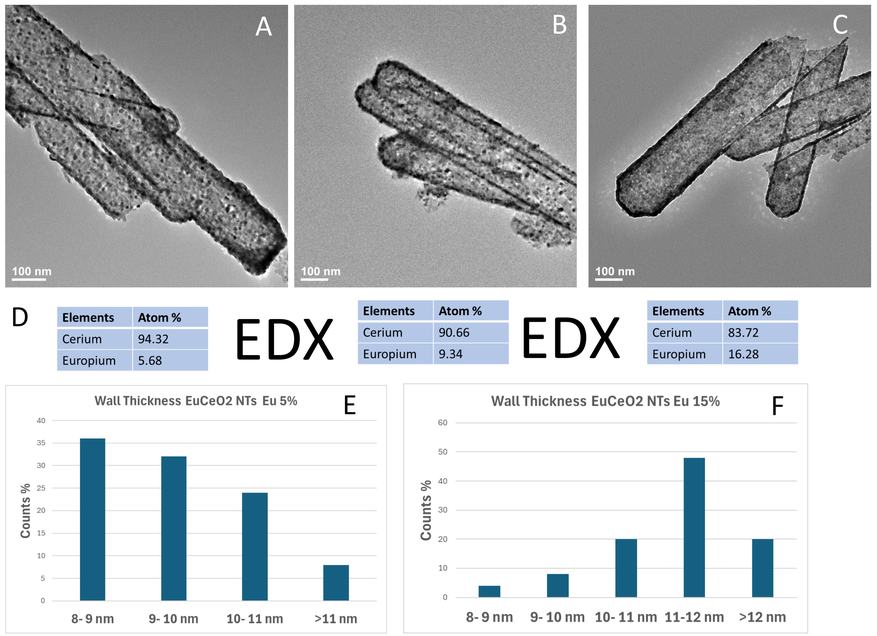

Fig 4. (A-C) TEM image of the $EuCeO_2$ NTs 5, 10, 15 % of Eu^{+3}. (D) Energy Dispersive X-ray (EDX) Elemental Analysis at 5, 10, 15% of Eu^{+3}. (E-F) Histograms of Wall Thickness of $EuCeO_2$ NTs 5% and 15%.

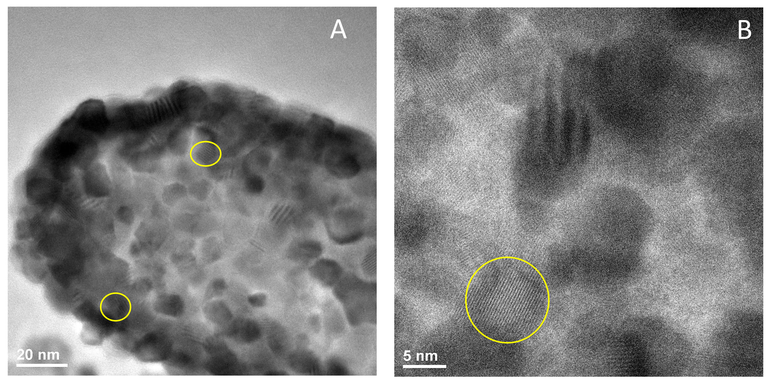

Fig 5. (A-B) High Magnification TEM pictures showing the different unit cells of CeO_2 conforming the nanostructure

III. Results

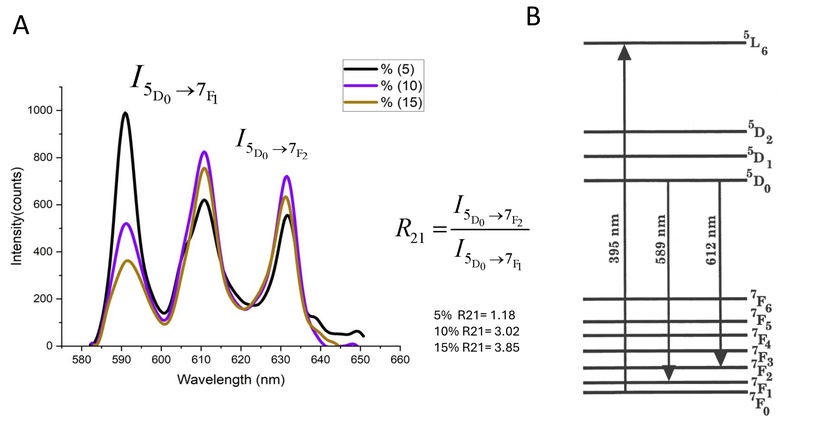

Fig 6. (A) Photoluminescence (PL) spectra of the $EuCeO_2$ NTs at 5,10,15 % of Eu^{+3}. 500 ms acquisition time (B) Energy diagram of Eu. Emission and fluorescence

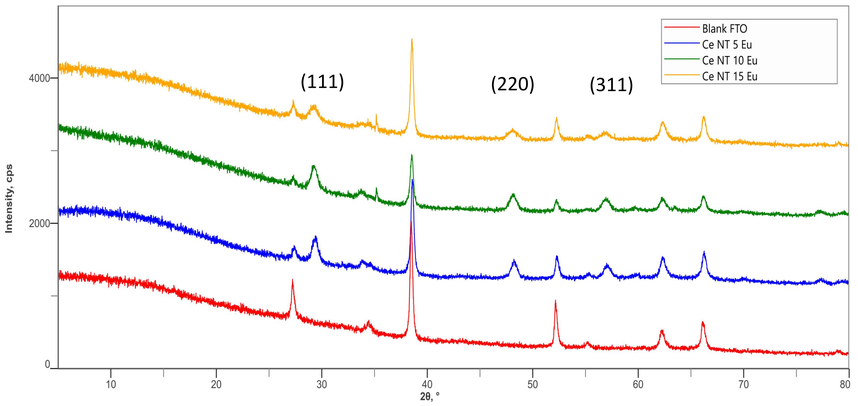

Fig 7. XRD Spectra of $EuCeO_2$ NTs at different concentrations of Eu^{+3}. Run by Maegyn Grubbs

IV. Conclusions and Future Work

- Observe this material in the confocal microscope
- Add cells to the material to watch the interface interaction between them in SEM and Confocal microscope.
- Increase the number of cycles to get a thicker wall and probably enhance the PL intensity
- The $EuCeO_2$ NTs at 10% of Eu^{+3} in terms of PL intensity and asymmetry are relevant to emphasize its study.

V. References

1. Anne D'Achille, Robert Wallace, Jeffery Coffer. **Morphology-dependent fluorescence of europium-doped cerium oxide nanomaterials.** ***Nanoscale Adv.***, 2021,**3**, 3563-3572
2. Roberto Gonzalez-Rodriguez, Jeffery Coffer, Jingbiao Cui. **Fabrication and characterization of 1D $MAPbI_3$ in Cerium Oxide Nanotubes.** To be published

VI. Acknowledgments

TCU Department of Chemistry and Biochemistry