On the array of 1 at.% Ce-doped ZnO nanorod prepared by electrochemical deposition with their structure and characterization

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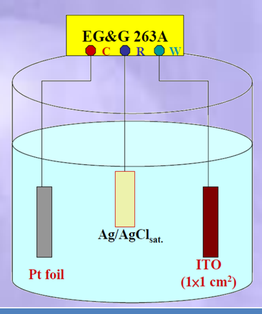
Abstract

ZnO-based semiconductor is a transparent material for many applications, such as some electronic devices, light emitting diode, fluorescent material, sensor, and solar cell. In this study, ZnO-nanorods were doped with 1 at.% Ce on ITO substrate by electrodeposition. We prepared our electrolyte from $ZnCl_2$ and H_2O_2, and 0.04M KCl. Our purpose is to improve ZnO's transmittance, and compare electrochemical curve with different precursor, $CeCl_3$ and $Ce(NO_3)_3$. We also investigate the influence when using different concentration of H_2O_2. We did many analysis to proof our result, such as Field-emission scanning electron microscope(FE-SEM), Alpha step, X-ray diffraction(XRD), X-ray photoelectron spectrometer(XPS).

Experimental

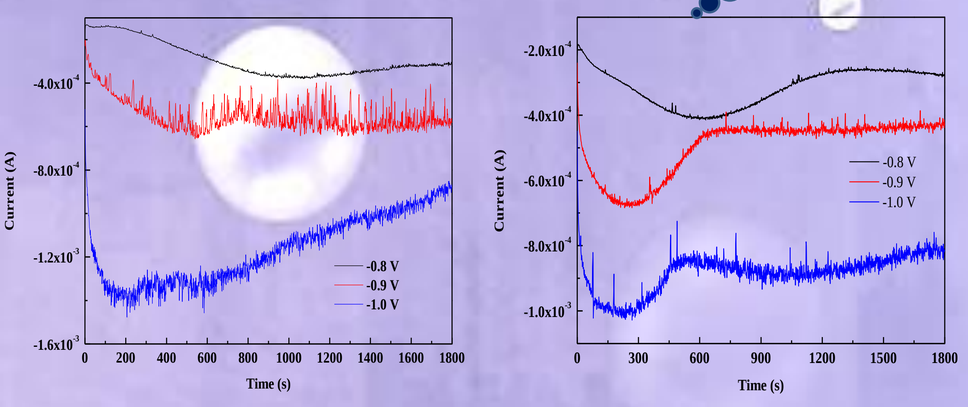
ITO pretreatment → OCP and PDS → Electrodeposition → SEM, XPS, PL, XRD, Transmittance



Electrolytes (80℃)			
1.98 mM $ZnCl_2$	0.02 mM $CeCl_3$ or $Ce(NO_3)_3$	2.45 mM H_2O_2	0.04M KCl
Cathode deposition			
Potentiostat (-0.8 ~ -1.0 V)			

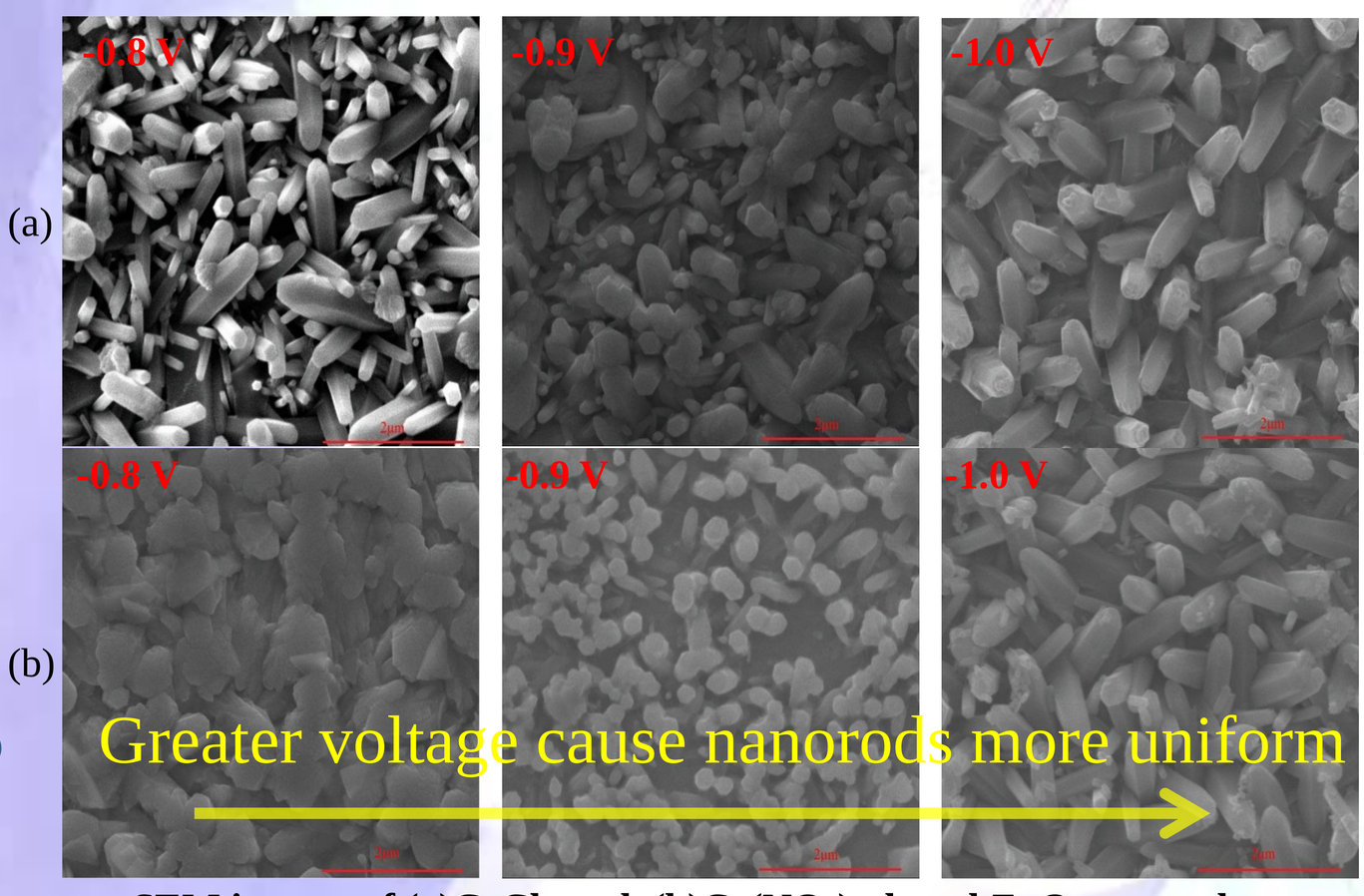
Result and discussion

V↑ I↑ $T_{reaction}$↓

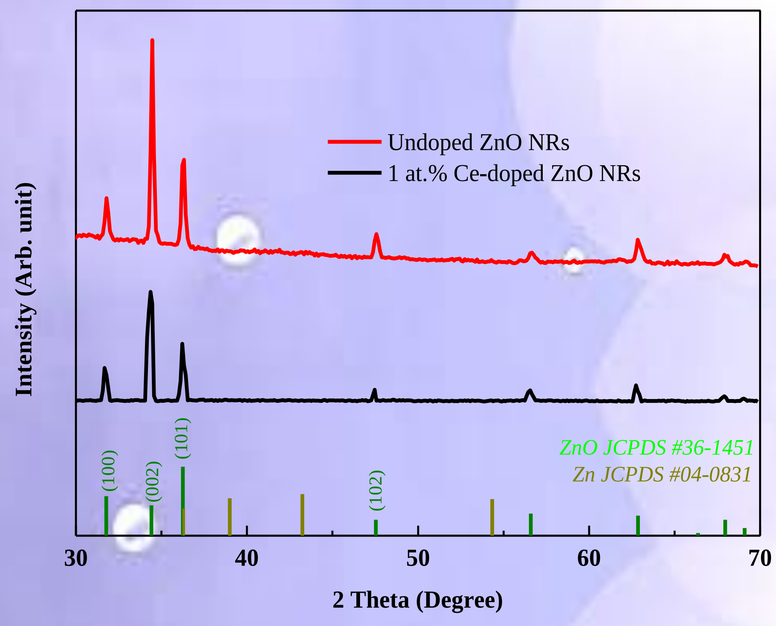


$CeCl_3$ and $Ce(NO_3)_3$ deposition

After achieving its maximum current, it start nucleating. And then cover ITO surface. Therefore the resistance become large, which cause current to decrease.

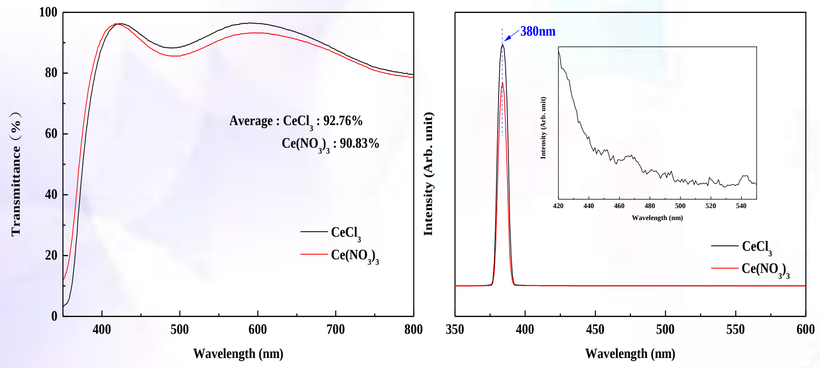


SEM images of (a)$CeCl_3$ and (b)$Ce(NO_3)_3$ doped ZnO nanorods

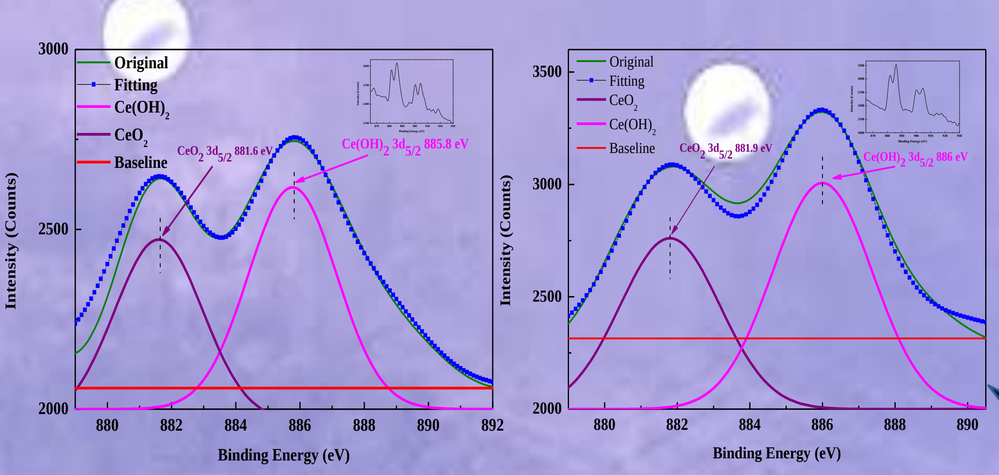


XRD image of undoped ZnO nanorods and Ce-doped ZnO nanorods.

This figure shows the preferred orientation is (002), and when we doped ZnO nanorodes with Ce, its intensity will decrease.



Transmittance and PL images of Ce-doped ZnO nanorods

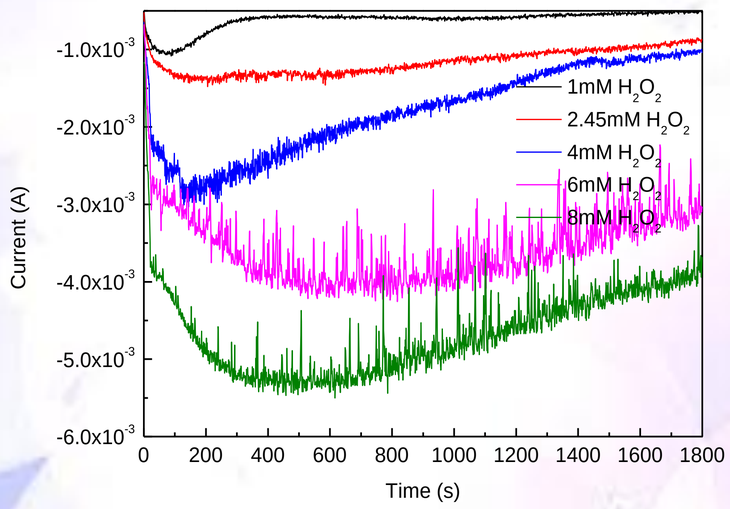


(c)

(d)

XPS images of (c)$CeCl_3$ and (d)$Ce(NO_3)_3$ doped ZnO nanorods

Ce $3d_{5/2}$ peak was located at 881.6 and 881.9 eV which indicates that this binding energy was attributed by Ce^{4+} ion doping.



$CeCl_3$ Deposition of different concentration of H_2O_2

Due to electrochemical active substances, the current will increase with the increasing concentration of H_2O_2.

Conclusion

- ✓ The transmittance exceed 90% which reach our goals.
- ✓ The best potential in our study to do cathode deposition is -1.0 V.
- ✓ Both $Ce(NO_3)_3$ and $CeCl_3$ are hexagonal wurtzite structure.
- ✓ There are good result of SEM when the concentration of H_2O_2 between 2.45 mM and 4 mM.

Reference

[1]黃茂嘉，「奈米氧化鋅結構之電化學研製及其在發光二極體之應用」，中央大學，碩士論文，民國100年。

[2]X.Y. Chen, F. Fang , A.M.C. Ng et al. *Thin Solid Films* **520,** 1125–1130, (2011)