Advanced photocatalytic properties of ZnO thin films prepared by plasma enhanced ALD

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Goals

- Study of photocatalytic activity of ZnO thin films prepared by thermal and plasma enhanced Atomic Layer Deposition (ALD)
- The photocatalytic degradation studies of methyl orange (MO) in the presence of ZnO thin films
- Difference in photocatalytic properties of thermal and PE-ALD made ZnO thin films

Experimental methods

ALD synthesis of ZnO thin films

	Thermal ALD	PE-ALD
Precursors in ALD	diethyl zinc + H_2O	diethyl zinc + 0_2 plasma
Temperature of deposition	100 ℃	100 ℃
Number of ALD cycles	634	415
Thickness of ZnO	100 nm	100 nm
Dimension of silicon substrate	0,7 cm × 0,7 cm	0,7 cm × 0,7 cm

Measurments

- Experiments were preformed ‘’in-situ’’ – in quartz cuvettes with light path of 10 mm.
- ZnO thin films were irradiated by two UV lamps of different strengths
- For measurment done with Intelli- Ray 600 UV oven was used MO solution of $c = 2,425 \cdot 10^{-3}$g/L.
- For measurments done with CAMAG UV Lamp 4 strenght 8 W and wavelength of 254 nm was used MO solution of $c = 1,21 \cdot 10^{-3}$g/L.
- The time dependent degradation process of MO in aqueous solution was monitored by Agilent Technologies Cary 60 UV/Vis spectrophotometer and analysed in QtiPlot.

References

1. R. Zha, R. Nadimicherla, X. Guo, J. Mater. Chem.A, 2015, 3, 6565.
2. S. Bhatia, N. Verma, Photocatalytic activity of ZnO nanoparticles with optimization of defects, Materials Research Buletin, 2017.

Acknowledgement

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Results

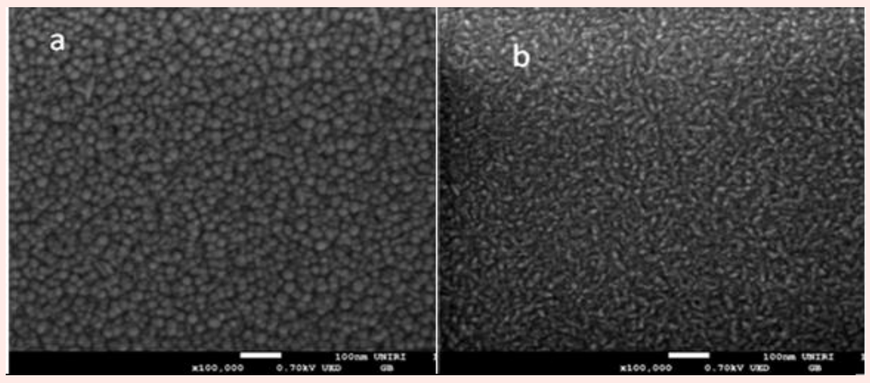

Figure 1. SEM pictures of (a) thermal and (b) PE-ALD made ZnO thin films.

Measurments with UV oven

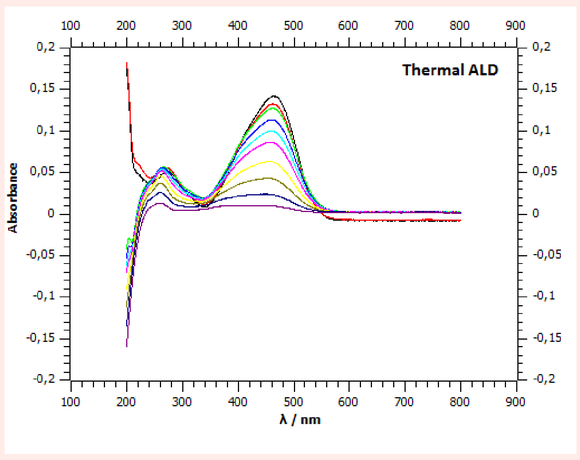

Figure 2. Absorbance spectrum of MO in the present of thermal ALD made ZnO.

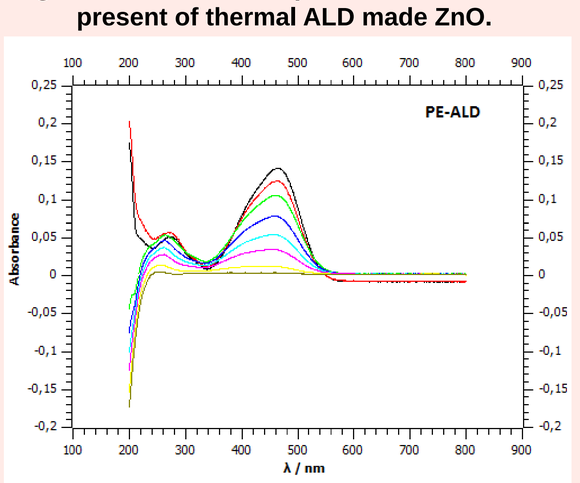

Figure 4. Absorbance spectrum of MO in the present of PE-ALD made ZnO.

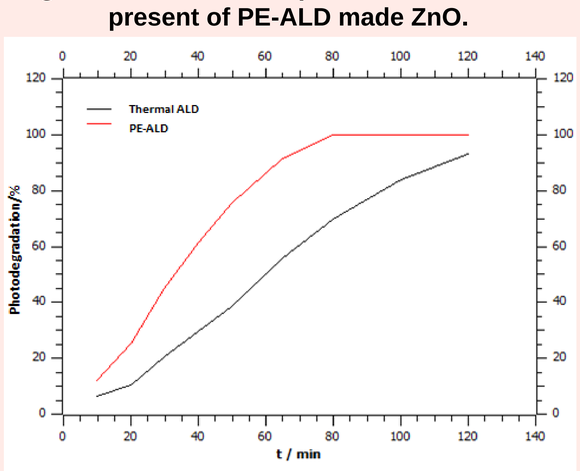

Figure 6. Percentage photodegradation of MO as a function of time.

Measurments with UV lamp

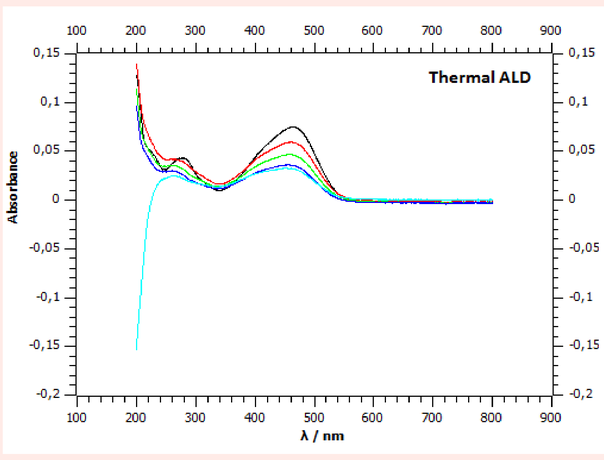

Figure 3. Absorbance spectrum of MO in the present of thermal ALD made ZnO.

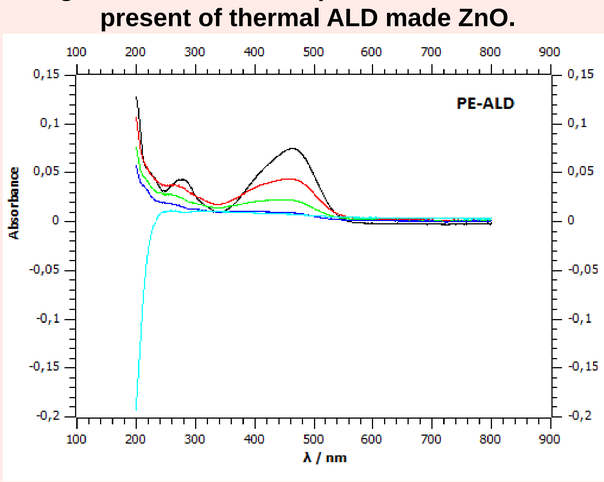

Figure 5. Absorbance spectrum of MO in the present of PE-ALD made ZnO.

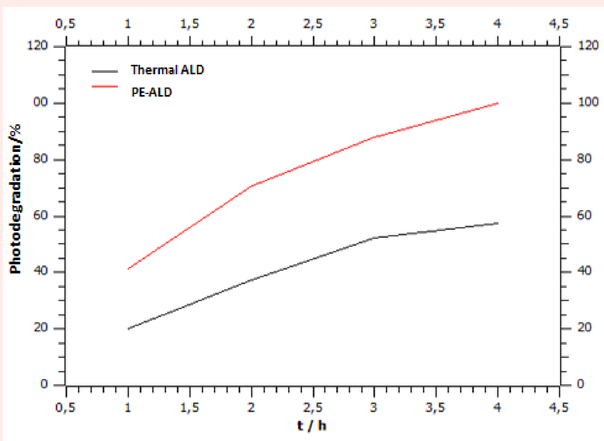

Figure 7. Percentage photodegradation of MO as a function of time.

Conclusion

- ZnO thin films successfully photodegraded MO in solution which show their photocatalytic activity.
- Significant increase in MO degradation rate when ZnO thin films prepared by PE-ALD were used as photocatalysts. This indicates that the plasma process induces the formation of a higher amount of electron-hole pairs on ZnO active surface which are responsible for the generation of reactive radicals and, consequently, enhanced photo-oxidation ability of PE-ALD made ZnO thin films.