Optoelectronics and Nanomaterials Laboratory

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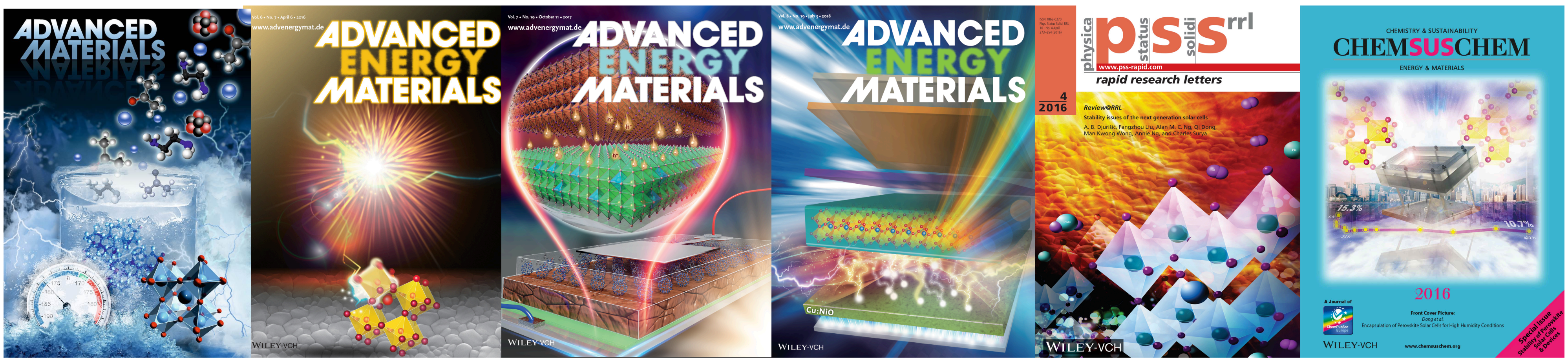
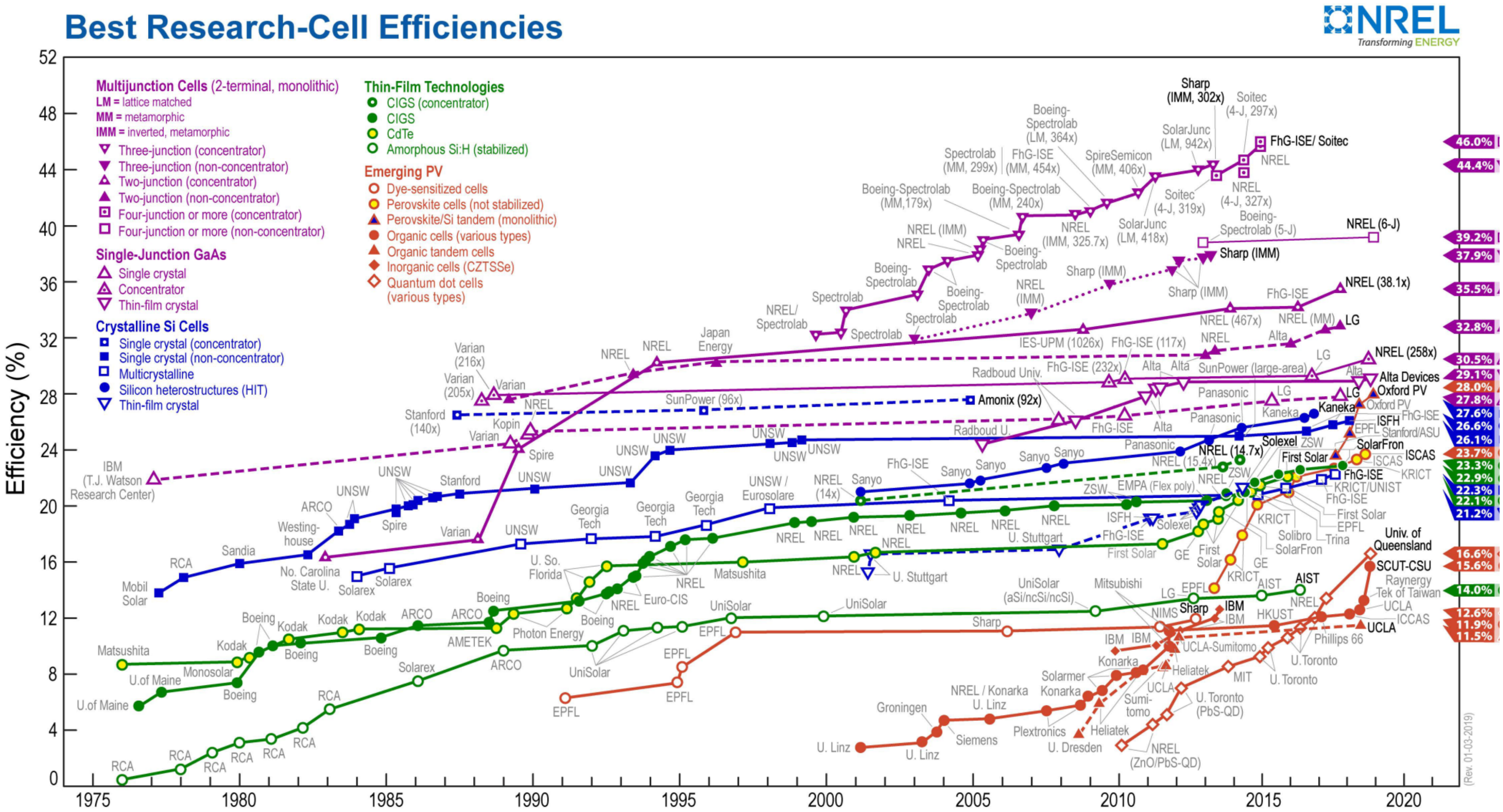
Topics

- **Perovskite materials and devices**
  - Materials synthesis and characterization
  - LED devices, focus on blue emission
  - Solar cells, focus on stability
- **Metal oxide photocatalysis**





Main advantage – high efficiency, low cost
Major problems: use of organic solvents, reproducibility, stability

Quasi-2D RP perovskite materials

- $A_2A'_{n-1}B_nX_{3n+1}$
- 2D (n=1), quasi 2D (n≥2), and 3D (n=∞)
- X is halide anion, B is divalent metal (Pb, Sn), A, A' are organic cations, or can be alkali metals such as Cs
- Common A=BA, PEA; common A'=MA, FA
- Quasi-2D higher stability, lower efficiency
- Goals – develop high efficiency, high stability devices

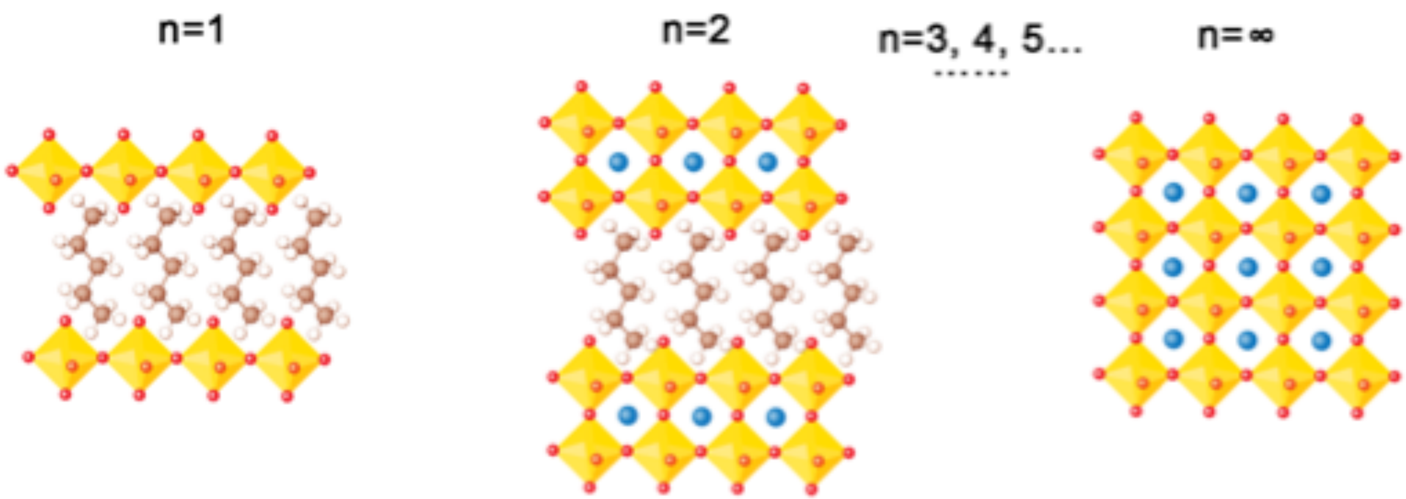
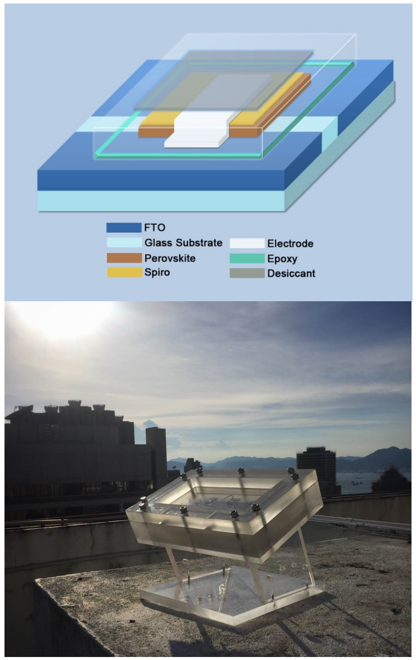


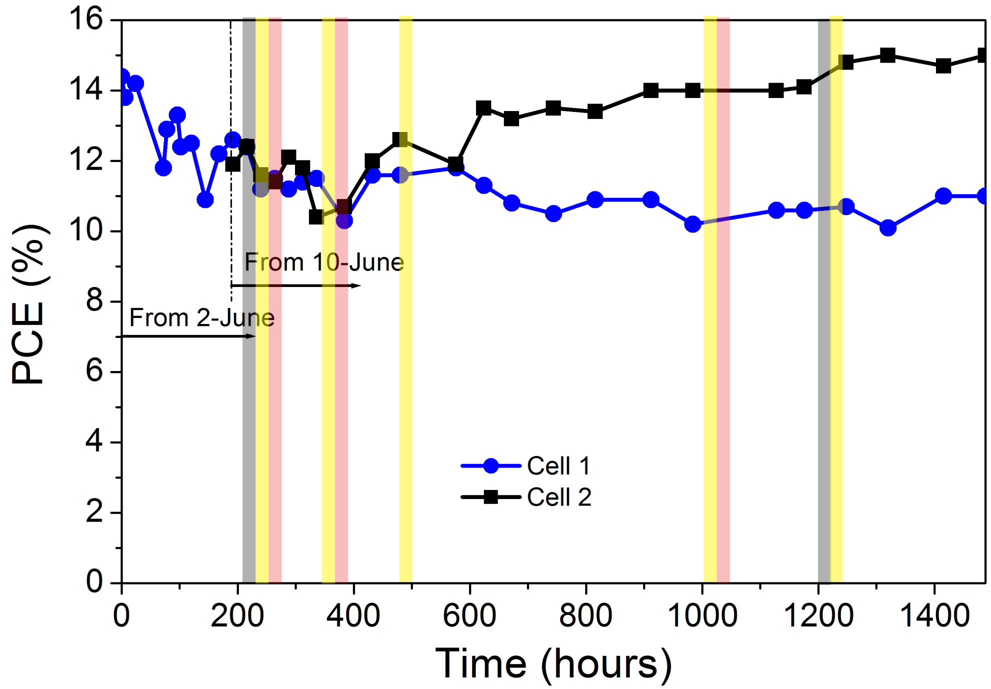
Figure 1. Illustration of multidimensionality in $A_2A'_{n-1}B_nX_{3n+1}$ perovskite materials

Encapsulation

- **Barrier layers and top surface encapsulation**
- **Edge sealants and desiccants**
- **Evaluating ambient stability (accelerated aging and outdoor), mechanical stability (bending tests), and Pb leaching.**



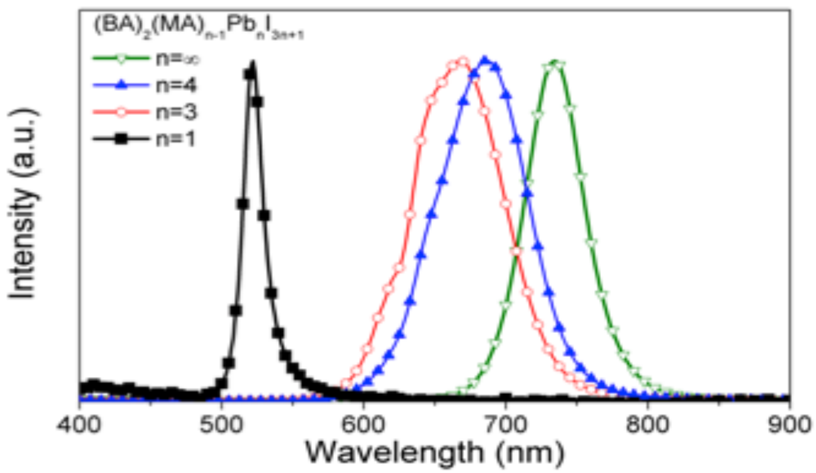
ChemSusChem 9, 2597, 2016



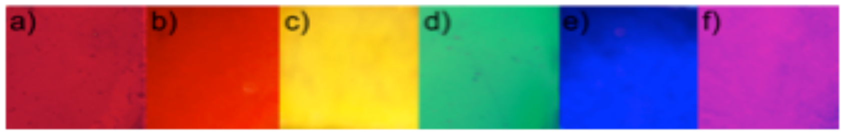
Outdoor tests, summer 2017; epoxy and desiccant developed at HKU.

LED Research

- Optimization of the deposition conditions of quasi-2D perovskite films (different strategies for different bulky organic cations)
- Passivation of traps
- Development of new materials for short wavelength emission



PL spectra of $(BA)_2(MA)_{n-1}Pb_nBr3_{n+1}$ with various n values



Photos of different BA-MA and BA-Cs lead and tin perovskite thin films under UV illumination

Metal oxide photocatalysis

- Objectives – study the fundamental mechanisms of catalysis and photocatalysis, development of efficient catalysts and photocatalysts
- Selected publications: J. Phys. Chem. C 115, 11095-11101, 2011; Appl. Catal. B 107, 150-157, 2011; J. Phys. Chem. C 117, 12218–12228, 2013; J. Phys. Chem. C 118, 22760-22767, 2014; J. Mater. Chem. A 3, 3627 - 3632, 2015.

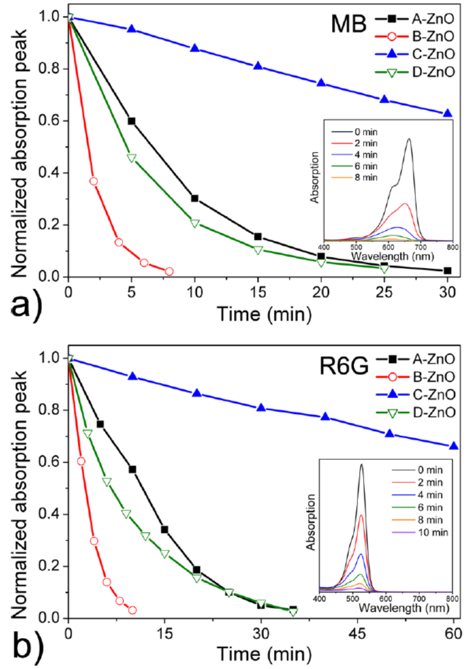


Figure 8. Degradation curves of cationic dyes for different ZnO nanoparticles (a) methylene blue and (b) rhodamine 6G. The insets show absorption spectra at different times corresponding to the fastest degradation curve.

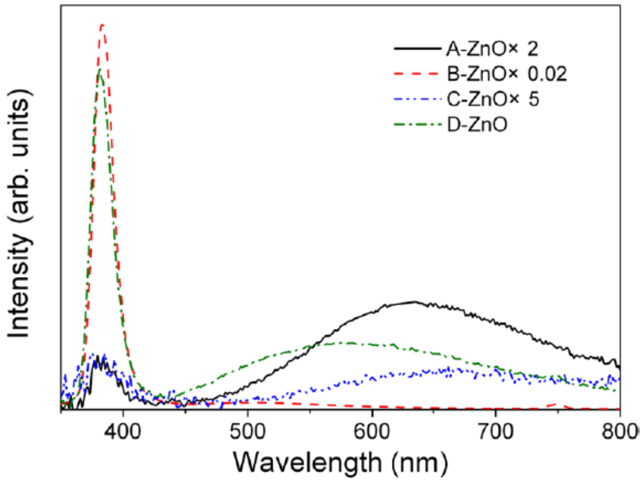


Figure 2. Photoluminescence spectra of different ZnO nanoparticles.

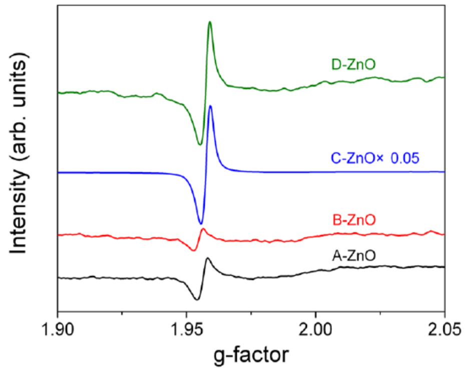
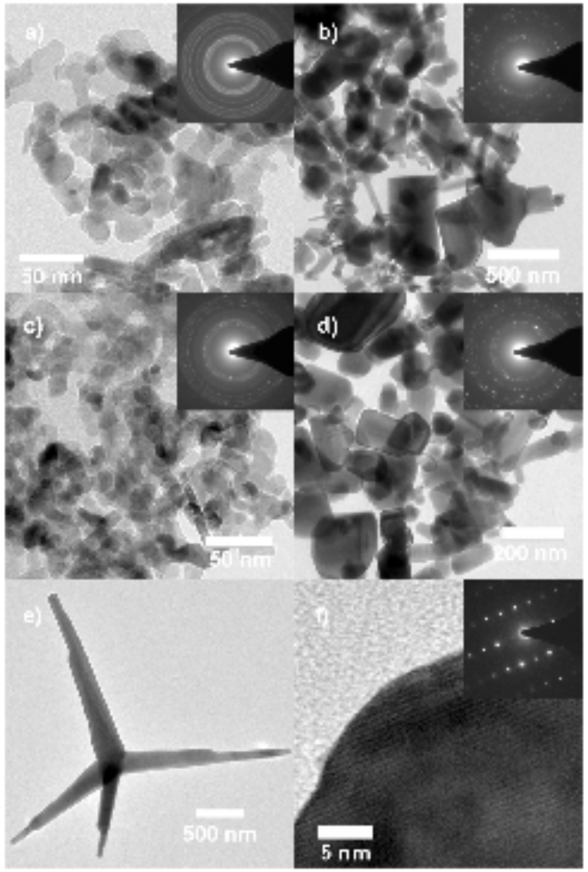


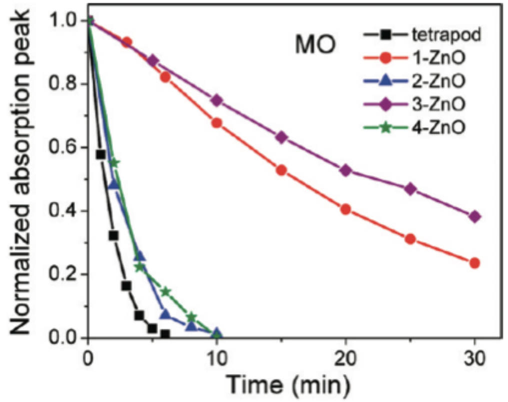
Figure 5. Electron spin resonance spectra for different ZnO nanoparticles.

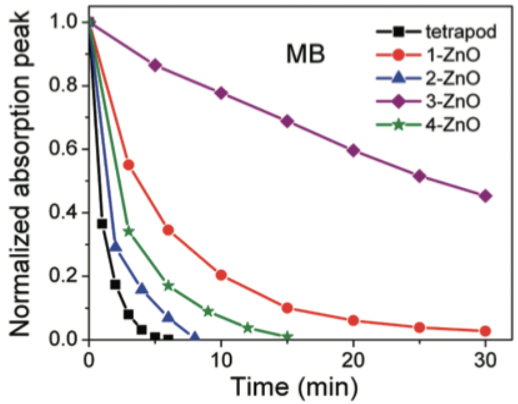
J. Phys. Chem. C, 117, 12218 (2013)

ZnO photocatalytic applications

	tetrapod	1-ZnO	2-ZnO	3-ZnO	4-ZnO
BET surface area (m^2/g)	2.2	45.9	7.0	60.7	10.0
aggregation size (nm)	>5000	220, 870	340, 860	>5000	350 (80%), 1000
PL decay time τ_1 (ns)	6.4 ± 0.9	0.028 ± 0.001	2.9 ± 0.2	1.3 ± 0.1	1.6 ± 0.1
PL decay time τ_2 (ns)	0.5 ± 0.05		0.24 ± 0.03	0.2 ± 0.02	0.17 ± 0.02







J. Phys Chem C 115, 11095 (2011)