$KTaO_3$ – BASED NANOCOMPOSITES FOR AIR TREATMENT

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INTRODUCTION

- One of the challenges in the field of photocatalytic air treatment systems is the development of third generation of photoactive materials activated by low powered and low cost irradiation sources (such as LEDs)

- The idea of preparing these materials according to the Serpone's theory is proposed (Fig.1)

- Formation of new generation components depends on level of energy bands in three semiconductors.

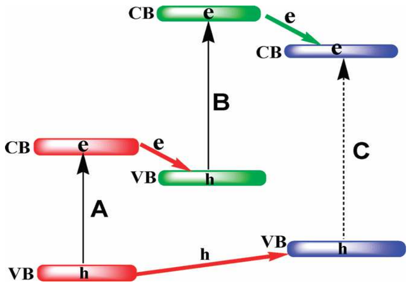


Fig. 1. The mechanism of excitation in three components nanostructures according to Serpone's theory [1]

- Multi(two)-photon excitation of photoactive materials with lower energy photons, utilization of heterojunctions to drive electronic processes in the desired direction, and selective photoexcitation of localized electronic states to gain better selectivity

PHOTOCATALYTIC SET-UP

Photocatalytic activity of prepared nanocomposites was estimated by photocatalytic degradationof toluene in the gas phase using a source of irradiation: LED 375nm.

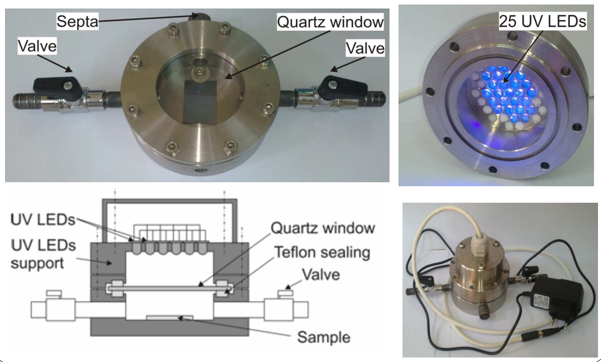


Fig. 2. Pictures of photoreactor and light sources LEDs 375 nm used for degradation of toluene in gas phase

PREPARATION PROCEDURE

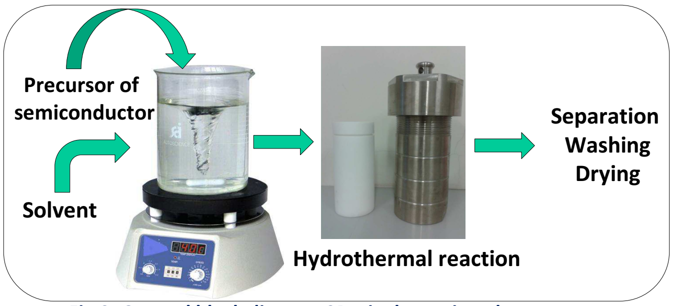
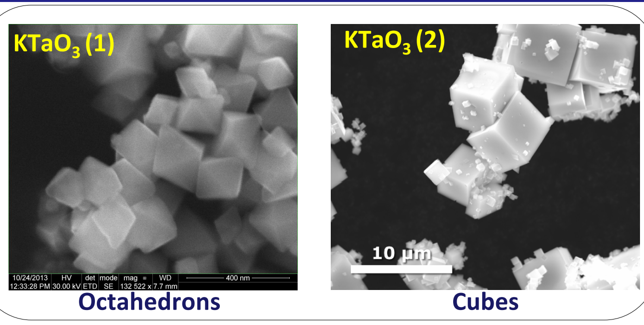


Fig.3. General block diagram 3D single semiconductors prepared by hydrothermal method

RESULTS



RESULTS

Table 2. The efficiency of toluene photodegradation over semiconductors (four cycles of irradiation; irradiation source: LEDs λ_{max}=375 nm)

Sample	Molar ratio of products	Preparation method	BET [m^2/g]	Degradation efficiency of toluen after 1 h irradiation (LEDs λ_{max}=375 nm)			
				I	II	III	IV
$KTaO_3$(1)-octahedrons	-	hydrothermal	22,2	44	38	37	33
$KTaO_3$(2)-cubes			0,1	64	63	42	37
WO_3	-		10,4	36	33	32	30
CdS	-		1,2	57	57	57	52
MoS_2	-		1,8	46	23	22	22
CdSe	-		12,7	28	27	26	19
$SrTiO_3$	-		17,8	41	39	35	34
$KTaO_3$(1)+WO_3	40:1	$KTaO_3$ + hydrothermal	2,0	37	39	22	15
$KTaO_3$(1)+CdSe	10:1	hydrothermal mixed solutions	33,9	42	38	37	33
$KTaO_3$(2)+CdS	10:1		17,5	47	45	41	40
$KTaO_3$(1)+CdS+ WO_3	10:1:1	KTaO3 + hydrothermal	2,6	51	32	33	29
$KTaO_3$(2) +CdS+MoS_2	10:5:1		4,6	59	56	56	55
$KTaO_3$(1) +CdSe+$SrTiO_3$	1:5:10	hydrothermal mixed solutions	56,8	60	39	38	35

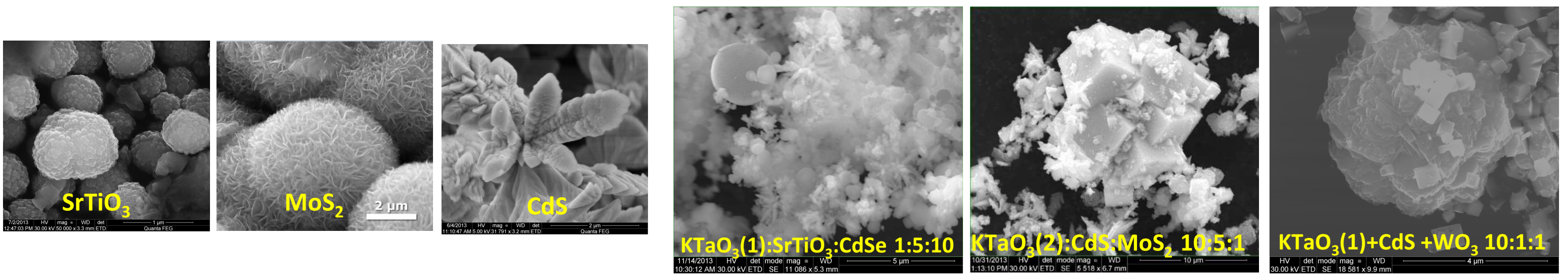


Fig.4. SEM images of semiconductors and their binary and ternary composites

CONCLUSIONS

- The results indicates that semiconductor nanocomposites based on $KTaO_3$ are effective in gas phase treatment using low powered irradiation source, e.g. LEDs.
- Structure of cubes $KTaO_3$ exhibited higher photocatalytic activity than octahedrons structure $KTaO_3$
- The decrease in photoactivity was observed for all single semiconductor (except CdS)
- The photocatalytic activity $KTaO_3$ (2) cubes - based slightly decreases after subsequent irradiation (about 3%)
- The photocatalytic activity $KTaO_3$ (1) octahedrons - based rapidly decreases after four cycles of irradiation
- The surface area of samples fluctuated from 0.1 to 56.8 m^2/g and was dependent on type/amounts of semiconductors as well as preparation methods.

REFERENCES

[1] N.Serpone, A.V. Emmeline, J. Phys. Chem. Lett. 3 (2012) 673-677.

ACKNOWLEDGEMENTS

This research was financially supported by National Centre of Research and Development (*PHOTOAIR* grant No. POL-NOR/207686/18/2013).

Wydruk plakatu współfinansowany przez Unię Europejską w ramach Europejskiego Funduszu Społecznego