Photocatalytic activity of melamine-modified rutile under UV and visible irradiation

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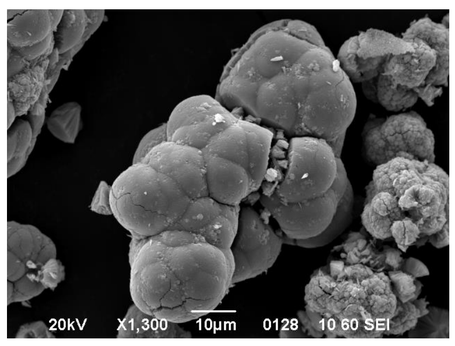
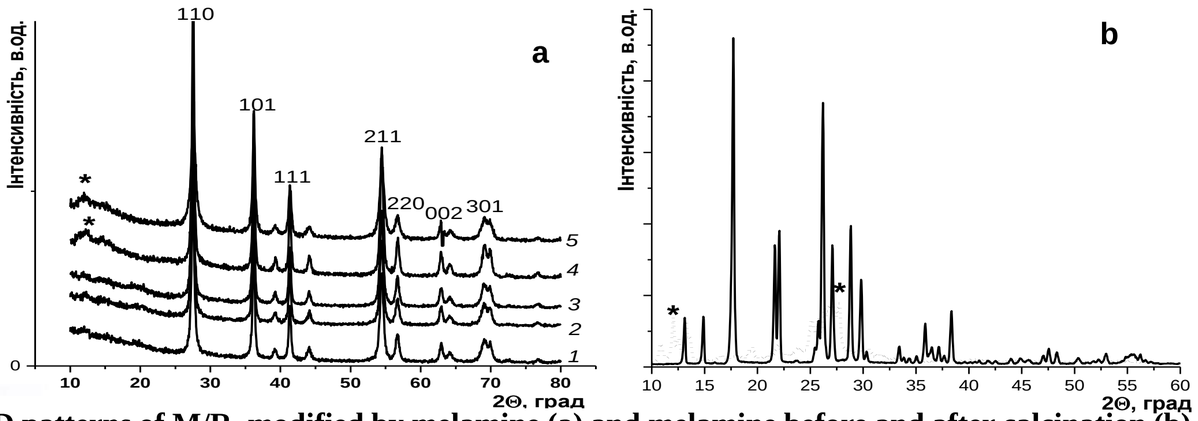
The aim of our work was to obtain and characterize the powders of rutile/TiO_2 (R) modified by melamine ($C_3H_6N_6$) with its subsequent thermal decomposition at 200, 300, 400, and 500 °C for 30 min (generally 2 hours) in inert atmosphere (Ar) in order to form carbon nitride on the surface of the catalyst. The samples also cooled in the inert atmosphere. Various amounts of melamine were used in the synthesis of modified rutile (M/R) samples. The powders have colors ranging from yellow to light brown and consist of agglomerates of round form measuring about 20-50 μm.



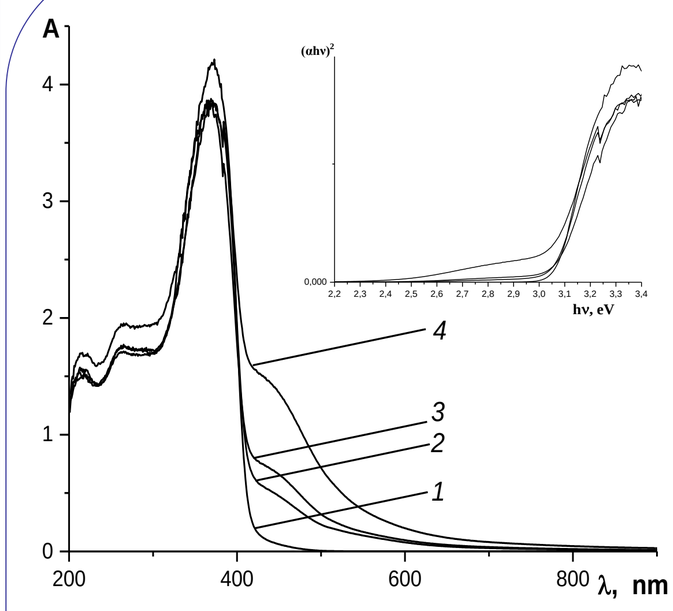
SEM-images of R, modified by melamine



XRD patterns of M/R, modified by melamine (a) and melamine before and after calcination (b)

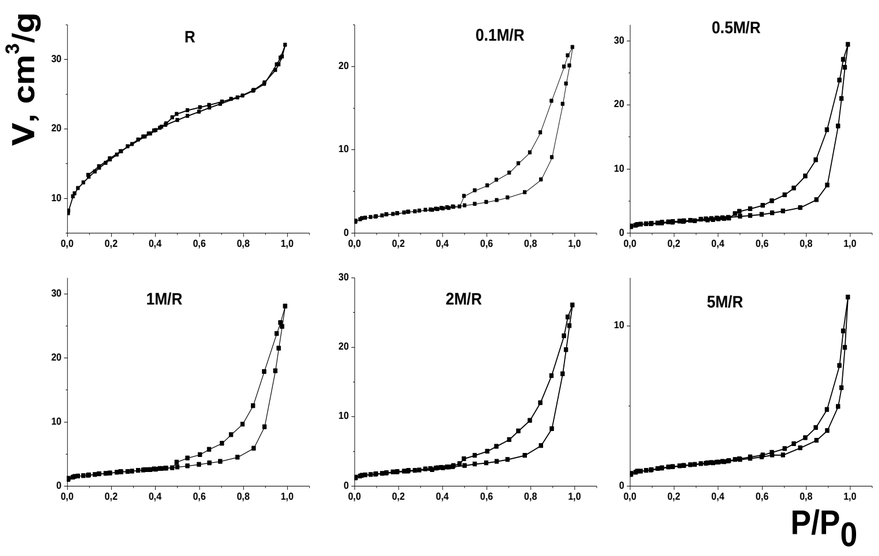
Table. Structural characteristics of the samples

Sample	S_{sp}, m^2/g	V_{tot}, cm^3/g	R, nm
R	9,7	0,05	10,8
0,1M/R	8,4	0,03	8,2
0,5M/R	6,4	0,05	14,3
1M/R	7,3	0,04	12,0
2M/R	7,4	0,04	10,9
5M/R	4,3	0,02	8,5

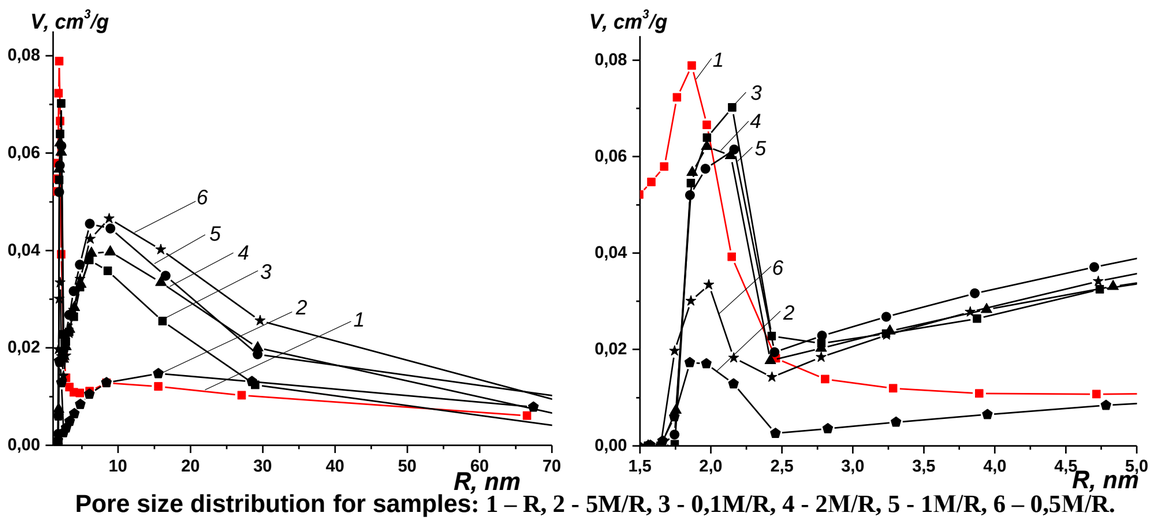


Absorption spectra of nanocomposites showed a bathochromic shift compared with the absorption band of pure rutile TiO_2. An absorption band in the visible region appears in the absorption spectra of the modified samples. The increase of melamine content lead to the absorption edge moves from 423 to 450 nm.

UV–Vis DRS spectra and corresponding plots of $(\alpha h\nu)^{1/2}$ versus photon energy (hv) of 1 – 0,1M/R; 2 – 0,5M/R; 3 – 1M/R; 4 - 2M/R.



Investigation of the sorption–desorption isotherms for the samples showed the presence in all cases of a hysteresis loop, indicating a mesoporous structure.



Pore size distribution for samples: 1 – R, 2 - 5M/R, 3 - 0,1M/R, 4 - 2M/R, 5 - 1M/R, 6 – 0,5M/R.

Powders are characterized by the presence of pores in the range of 1.5 - 2.5 nm and 2.5 - 20 nm with a predominance of larger pore diameters.

Table. Photocatalytic activity of investigated samples in the destruction of Safranine T and Rodamine B

Samples	k_d, x 10^{-5}, c^{-1}					
	Safranine T			Rodamine		
	a,%	UV	VIS	a,%	UV	VIS
Without photocatalyst	-	0,2	-	-	0,2	-
R/TiO_2	11,4	1,4	-		1,5	-
0,1M/R	9,5	1,6	0,7	5,4	4,9	1,4
0,5M/R	12,8	6,9	2,2	6,7	11,4	8,9
1M/R	12,8	6,2	1,9	3,7	5,0	5,5
2M/R	9,2	5,5	1,6	4,3	4,4	4,5
5M/R	3,6	3,9	1,5	4,6	3,2	1,0

Summary: Modified samples showed higher photocatalytic activity in the destruction of organic dyes Safranine T and Rhodamine B under UV and visible irradiation compared to unmodified rutile. Photocatalytical activity of different samples did not vary substantially during 5 cycles of exploitation.