SYNTHESIS AND CHARACTERISATION OF POLYSTYRENE TEMPLATED ZIF-8(Zn/Ti)

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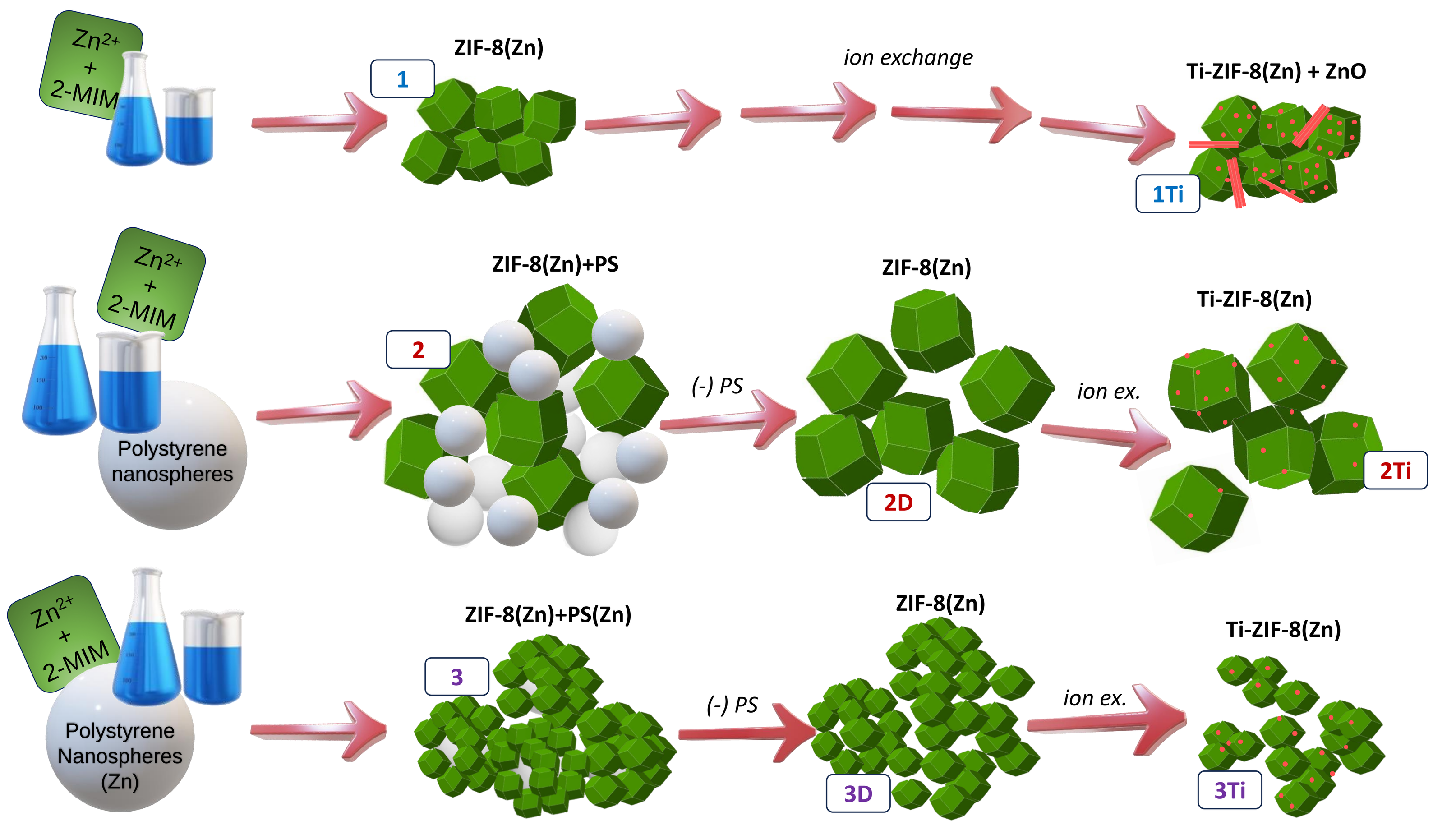
HR EXCELLENCE IN RESEARCH

INTRODUCTION:

ZIF-8 is a metal-organic framework (MOF) built of Zn^{2+} ions connected with 2-methylimidazole. Owing to its developed surface area, tunable pore size, chemical stability, and biocompatibility it may find application in catalysis, adsorption of pollutants from waste waters, gas purification, and drug delivery.

THE AIM OF THE RESEARCH:

- ✓ Finding an effective way for synthesizing ZIF-8(Zn) using polystyrene template (PS).
- ✓ Determination of physicochemical properties of templated ZIF-8(Zn).
- ✓ Investigation of the efficiency of Zn to Ti ion exchange in the templated ZIF-8.



STRUCTURE AND MORPHOLOGY:

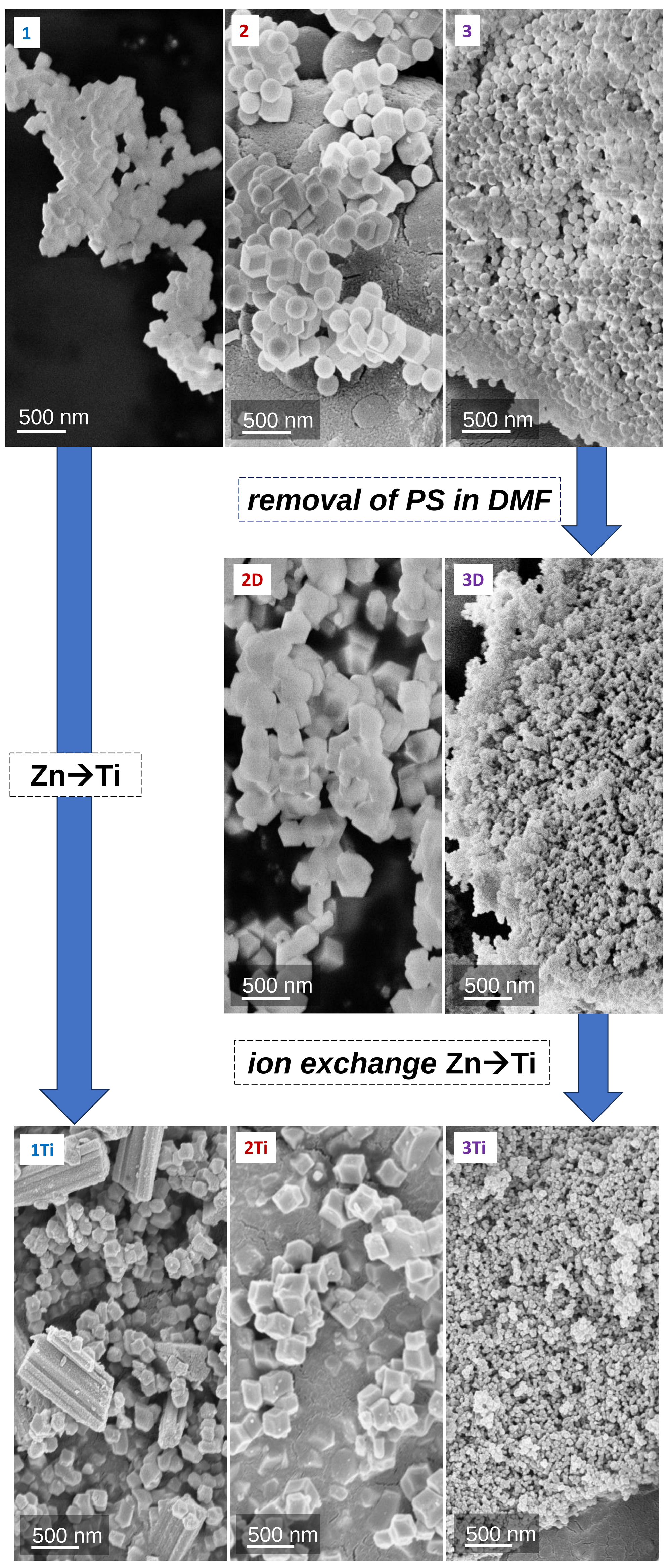


Fig. 1. SEM pictures of obtained materials.

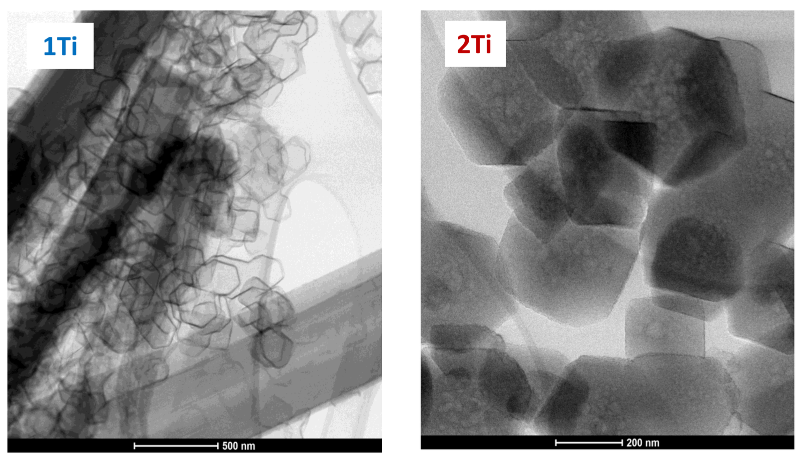


Fig. 2. TEM pictures of 1Ti and 2Ti samples.

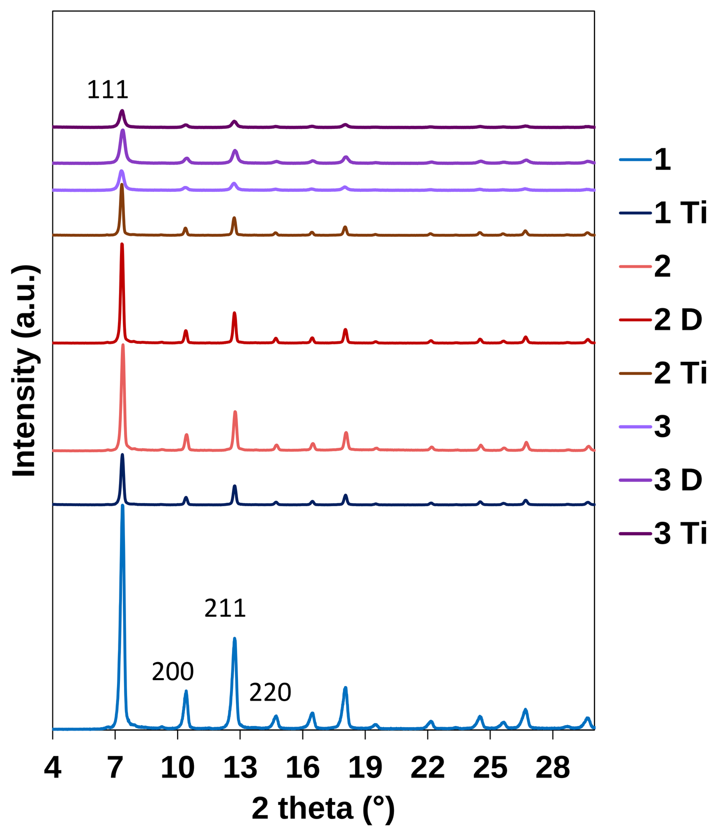


Fig. 3. XRD patterns of obtained materials.

Tab. 1. Mean sizes of ZIF-8 crystallites (d) in all of the obtained materials.

Sample	d (nm)			
	[110]	[200]	[211]	[220]
1	**39**	**38**	**34**	**34**
1 Ti	51	55	52	56
2	**48**	**50**	**48**	**48**
2 D	54	56	54	57
2 Ti	53	58	53	58
3	**29**	**32**	**29**	**33**
3 D	29	32	29	31
3 Ti	31	34	30	43

CHEMICAL COMPOSITION AND TEXTURAL PROPERTIES

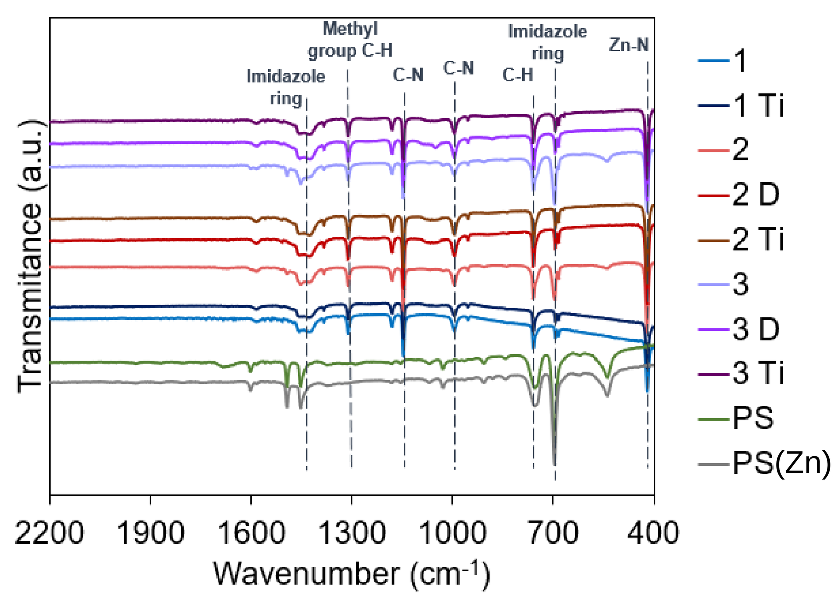


Fig. 4. FTIR spectra of PS and PS-templated ZIF-8 samples.

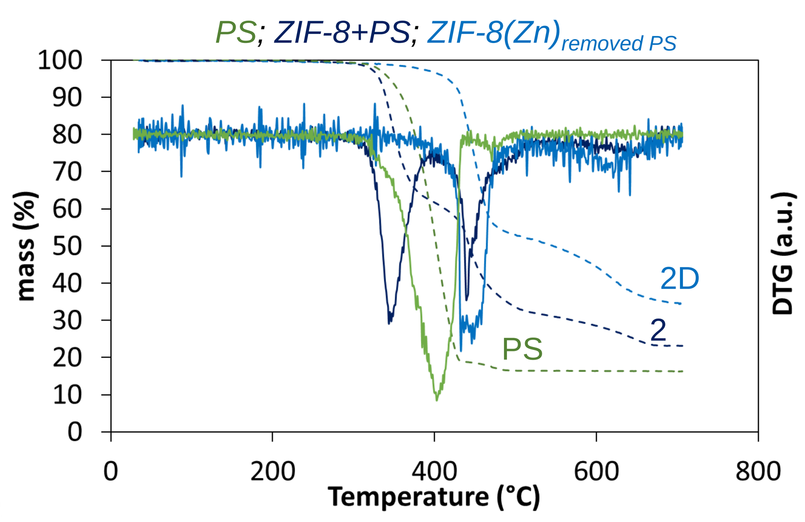


Fig. 5. TG and DTG profiles of PS and ZIF-8(Zn) templated on PS.

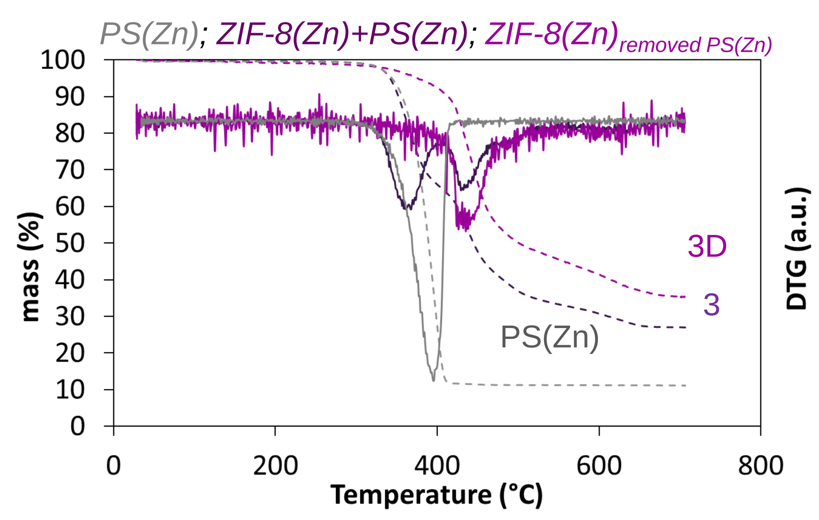
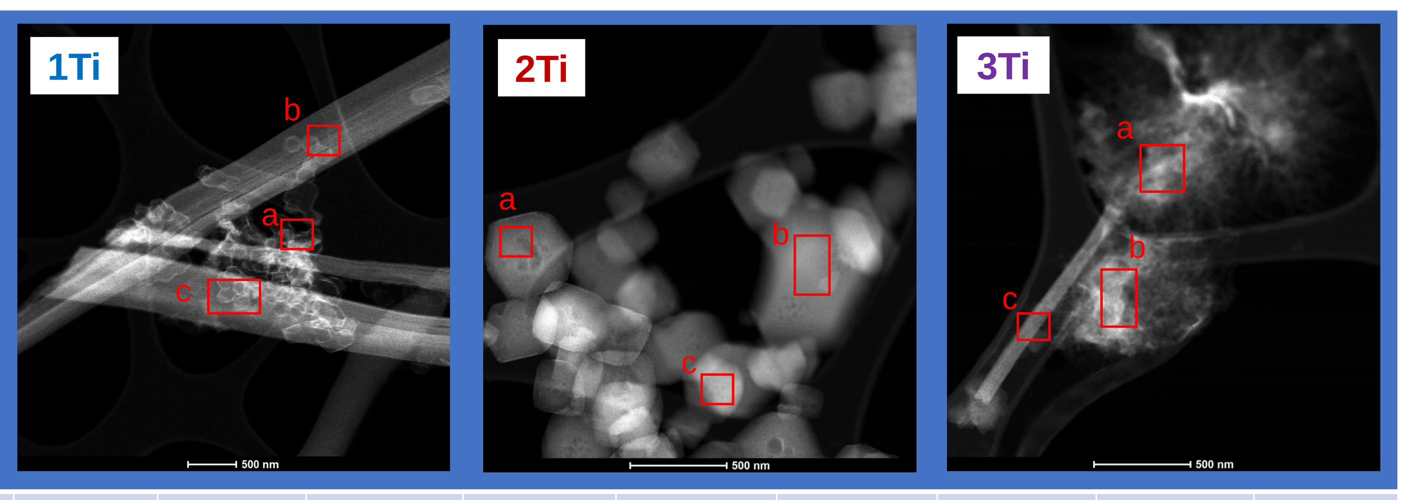


Fig. 6. TG and DTG profiles of PS(Zn) and ZIF-8(Zn) templated on PS(Zn).

Tab. 2. Composition of obtained samples as determined by TGA.

	2	2 D	3	3 D
	Composition (wt.%)			
PS	37.3	8.6	33.3	13.9
ZIF	62.7	91.4	66.7	86.1

Tab. 3. Zn and Ti concentration in 1Ti, 2Ti and 3Ti as determined by SEM-EDS.



point	a	b	c	a	b	c	a	b	c
Zn (wt.%)	23.25	7.49	12.39	19.10	16.95	15.55	21.21	9.52	13.54
Ti (wt.%)	9.40	33.74	31.54	0.11	0.02	0.13	0.85	0.90	5.51

Tab. 4. Textural properties of obtained materials.

Sample	BET (m^2/g)	V_t (cm^3/g)	V_{mic} (cm^3/g)	D (nm)
1	**1135**	**0.171**	**0.546**	**1.42**
1Ti	841	0.299	0.326	1.38
2	**722**	**0.102**	**0.288**	**3.51**
2D	1060	0.135	0.418	3.55
2Ti	1010	0.111	0.399	3.52
3	**943**	**0.669**	**0.342**	**1.39**
3D	1009	0.732	0.371	1.41
3Ti	912	0.753	0.337	1.40

BET – specific surface area determined using Brunauer-Emmett-Teller method, V_t – total pore volume, V_{mic} – micropore volume, D – pore diameter.

CONCLUSIONS:

1. A crystalline ZIF-8(Zn) was successfully obtained without and with the PS nanospheres (Fig 3).
2. Application of PS(Zn) as a template allows for obtaining morphologically homogeneous core-shell type composite (Fig. 1).
3. The ZIF-8(Zn) crystallites obtained with PS(Zn) are smaller compared to PS templated material (Tab. 1).
4. Formation of the core-shell structure composite restricts the DMF access to PS nanospheres, and results in lower efficiency of PS removal (Tab. 2, Fig. 6).
5. The highest amount of Ti was introduced to pristine ZIF-8(Zn). The presence of PS nanospheres in templated samples reduces the ability of Ti to substitute Zn (Tab.3).
6. Regardless the synthesis method, all of the obtained materials retain their mean pore diameter (Tab. 4).
7. However, the BET surface area:
   - decreases when PS is used as a template,
   - increases after PS removal in DMF, and
   - to some extend decreases when Ti introduction is more effective (Tab.4).

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