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Synthesis and study of properties of ZrO_2-based catalysts

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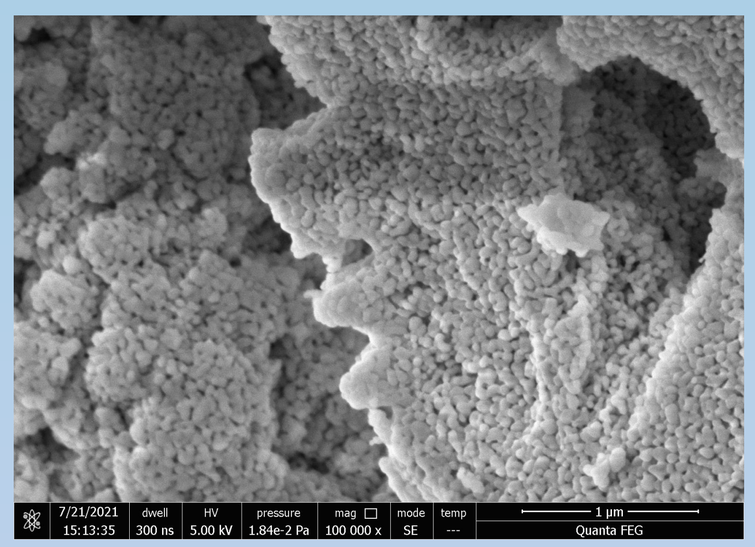
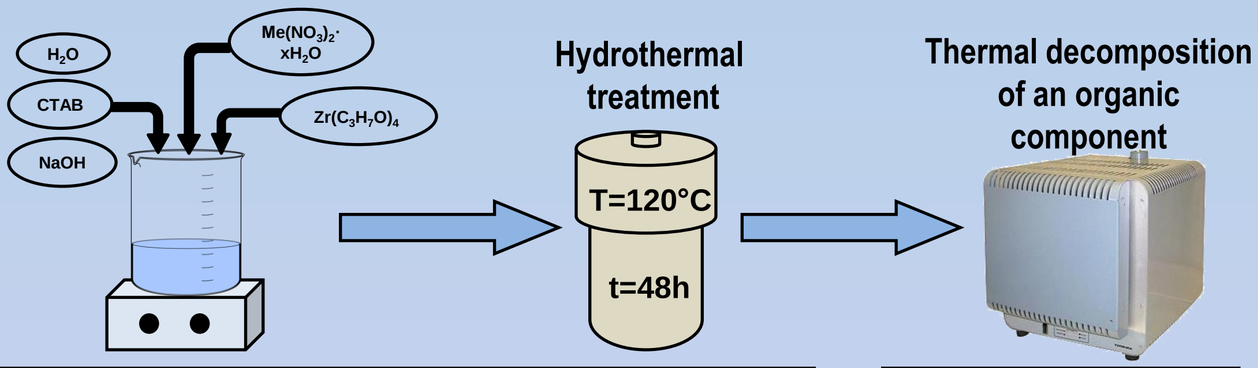
Transition metals and their oxides are well-known as catalysts for oxidation-reduction processes. An important stage for the creation of highly efficient catalytic systems is the search and development of carrier synthesis methods that have a direct impact on their structure and catalytic properties [1, 2].

Zirconium dioxide has a number of valuable properties (chemical resistance, high temperature resistance to destruction and sintering) that determine its use as a carrier for catalytically active particles of various high-temperature processes; as well as the presence of weak acidic and basic centers, stability in oxidizing and reducing atmospheres that determine its use as a catalyst [3].



SEM images of ZrO2

Sample synthesis scheme



100	: 0,44	: 0,4	: 1	: 0,1
H_2O	: CTAB	: NaOH	: $Zr(C_3H_7O)_4$	: $Me(NO_3)_2 \cdot xH_2O$

Temperature	650 ° C
Time	5 h

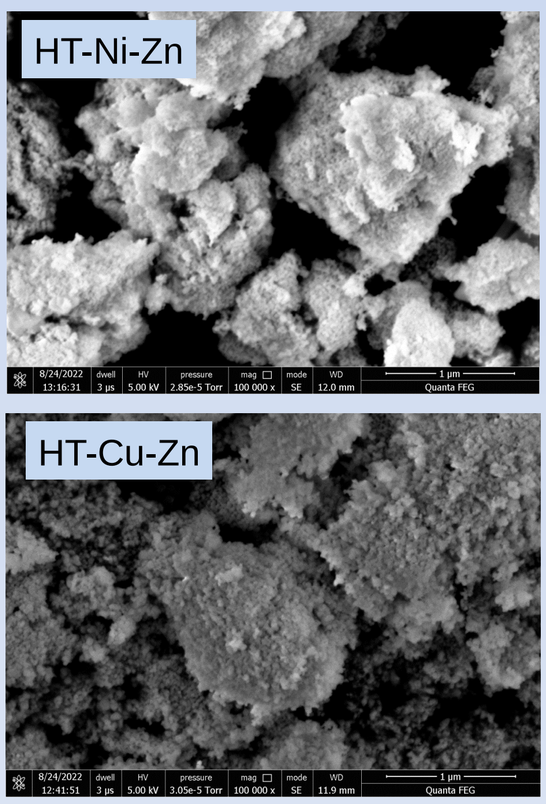
This paper presents the results of a study of properties of combined ZrO_2-based catalysts which are modified by transition metal oxides (copper/zinc and nickel/zinc) are reported.

The effect of the method of doping with copper, nickel and zinc compounds on the phase composition, porous structure, particle size and catalytic activity of synthesized catalysts is studied.

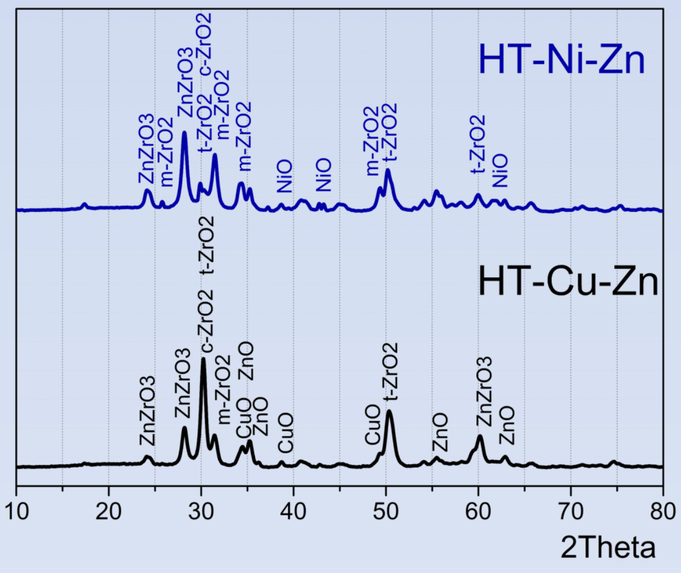
It was found that the samples obtained by template hydrothermal synthesis, followed by template removal (CTAB), have a specific surface area of 33,3 m^2/g (copper/zinc) and 34,4 m^2/g (nickel/zinc), which is higher than the textural characteristics of commercial zirconium dioxide (8.7 m^2/g).

Texture properties of synthesized samples

Sample	Phase composition	S_{BET}, m^2/g	V_{tot}, cm^3/g	D_{BJH}, nm	Crystallite size, nm
ZrO_2	m-ZrO_2 (P21/a)	8,71	0,063	20,41	29,0
HT-Ni-Zn	m-ZrO_2+ t-ZrO_2+NiO(Fm3m)	34,43	0,22	20.6	12,6
HT-Cu-Zn	m-ZrO_2+ t-ZrO_2+ ZnO(P63mc)+CuO(C2/c)	33,29	0,24	19,9	13,5



SEM images of synthesized samples



X-ray phase analysis of synthesized samples

The phase composition of these samples is a mixture of monoclinic form and high-temperature cubic modification of ZrO_2. The crystallite sizes in these samples are 13,5 and 12,6 nm. It is shown that the sample containing nickel and zinc oxides exhibits the greatest catalytic activity.

[1] R. Dong, H. Wang, Q. Zhang, X. Xu, F. Wang, B. Li. *CrystEngComm journal* **2015,** 17(38), pp. 7406–7413.
[2] S. Dey, G.C. Dhal, D. Mohan, R. Prasad. *Bulletin of Chemical Reaction Engineering & Catalysis* **2017,** 12 (3), pp. 393-407
[3] S. Kouva, K. Honkala, L. Lefferts, J. Kanervo. *Catalysis Science & Technology*, **2015**, 5(7), pp. 3473–3490.

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