Support Information

Table S1. Unit cell parameters for HZSM-5/Al_2O_3 material and Zr- and Mg- modified samples.

№	Samples	a, Å	b, Å	c, Å	Volume, Å^3
1	HZSM-5/Al_2O_3	20.162	20.002	13.432	5416.8
2	Zr-HZSM-5/Al_2O_3	20.123	19.942	13.466	5431.3
3	Mg-HZSM-5/Al_2O_3	20.176	19.991	13.392	5374.3

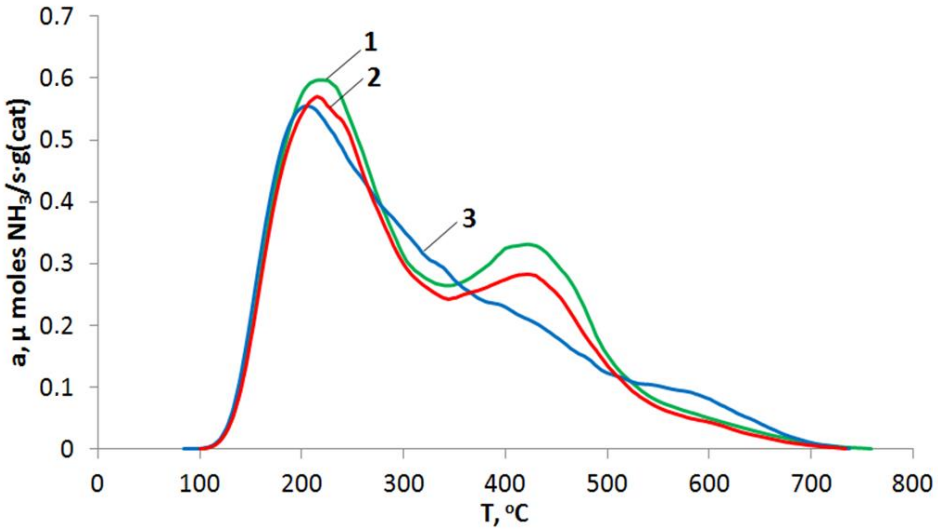


Fig. S1. NH_3 TPD profiles of the fresh HZSM-5/Al_2O_3, Zr- and Mg-modified samples. 1 – HZSM-5/Al_2O_3, 2 – Zr-HZSM-5/Al_2O_3, 3 – Mg-HZSM-5/Al_2O_3. Total Acidity, μmol NH_3/ g (cat): 1 – 1005, 2 – 924, 3 – 952.

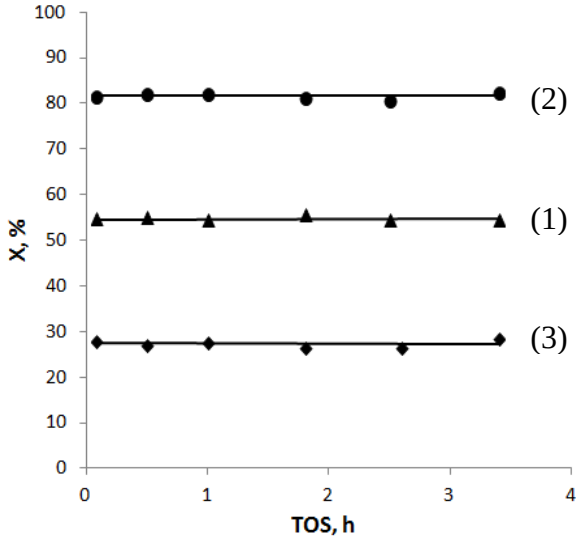


Fig. S2. Conversion of DME (X(DME)) as a function of time on stream (TOS). 1 – HZSM-5/Al_2O_3, 2 – Zr-HZSM-5/Al_2O_3, 3 – Mg-HZSM-5/Al_2O_3. T = 320°C, P = 0.1 MPa, τ = 0.82 g(cat)/g(C)*h.

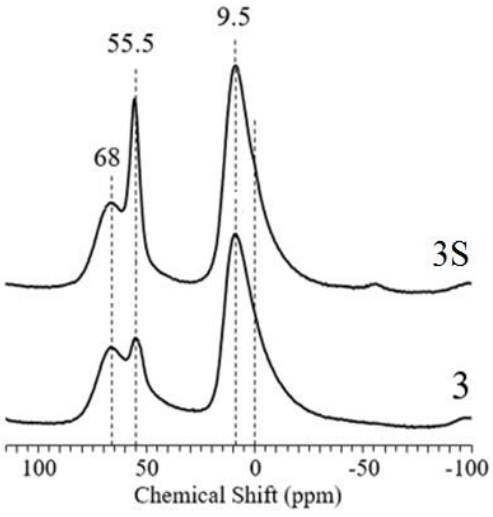
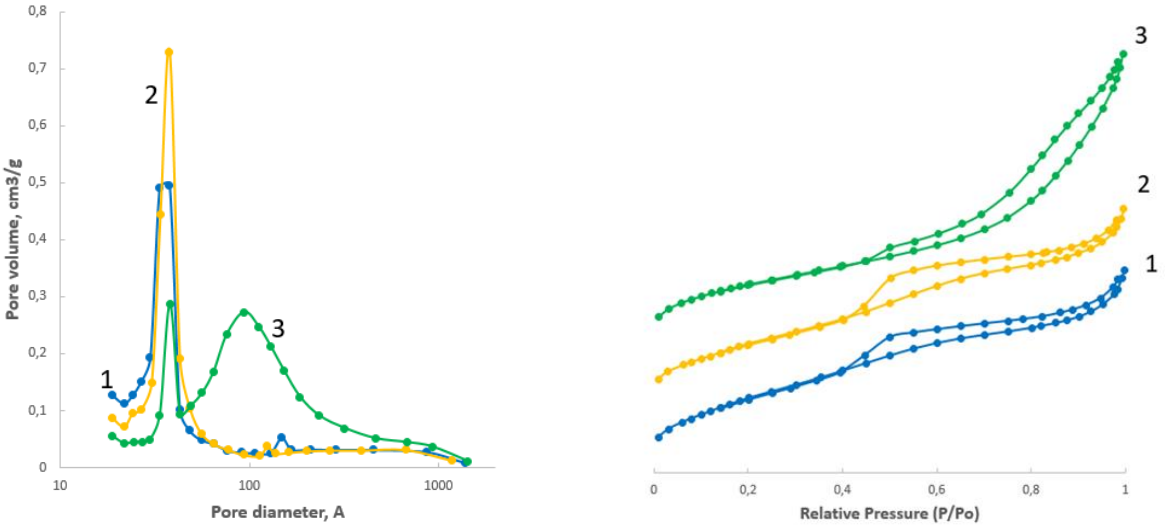


Fig. S3. ^{27}Al MAS NMR spectra of Mg-HZSM-5/Al_2O_3. 3 - hydrothermally treated sample, 3S - fresh sample.



A) B)

Fig. S4. The pore size distribution (A) (BJH method) and BET isotherms (B).
1 – HZSM-5/Al_2O_3, 2 – Zr-HZSM-5/Al_2O_3, 3 – Mg-HZSM-5/Al_2O_3.

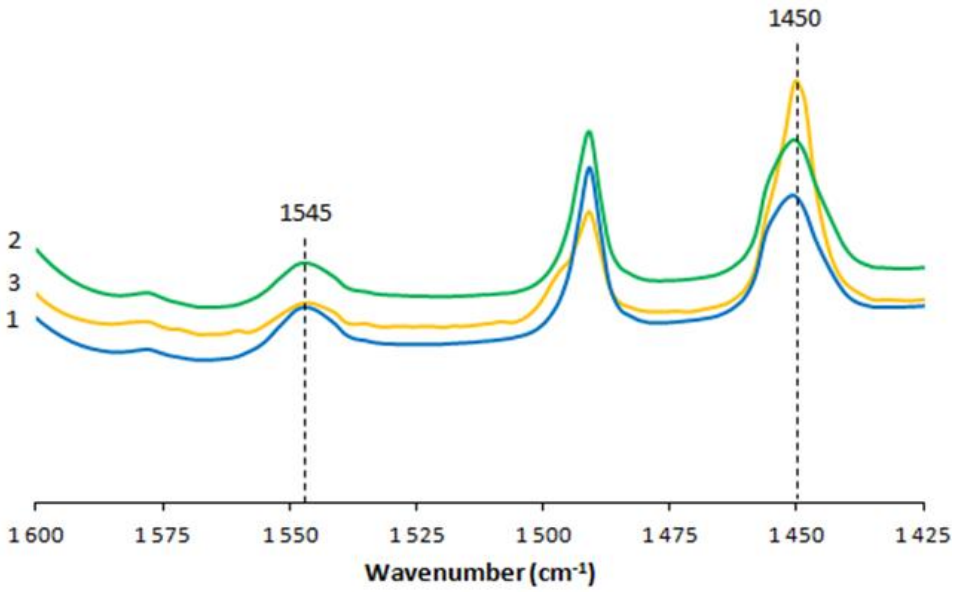


Fig. S5. IR spectra of pyridine adsorbed at 150°C.
1 – HZSM-5/Al_2O_3, 2 – Zr-HZSM-5/Al_2O_3, 3 – Mg-HZSM-5/Al_2O_3.

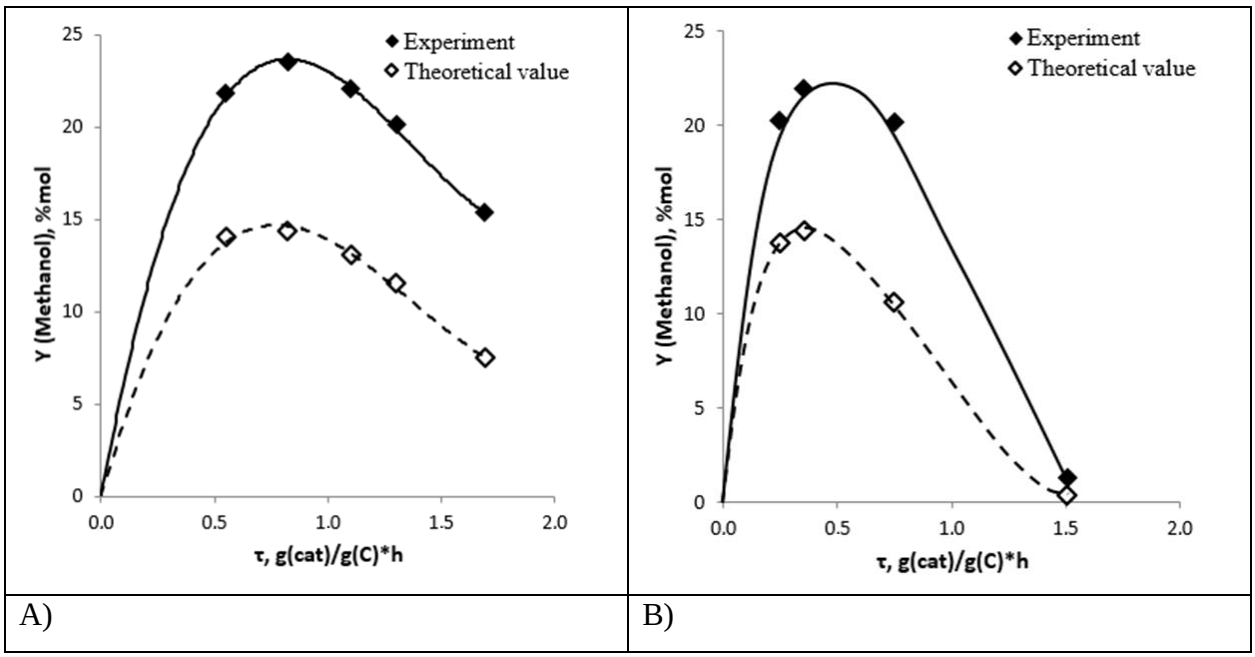


Fig. S6. The experimental and equilibrium yield of methanol for HZSM-5/Al_2O_3 (A) and Zr-HZSM-5/Al_2O_3 (B).

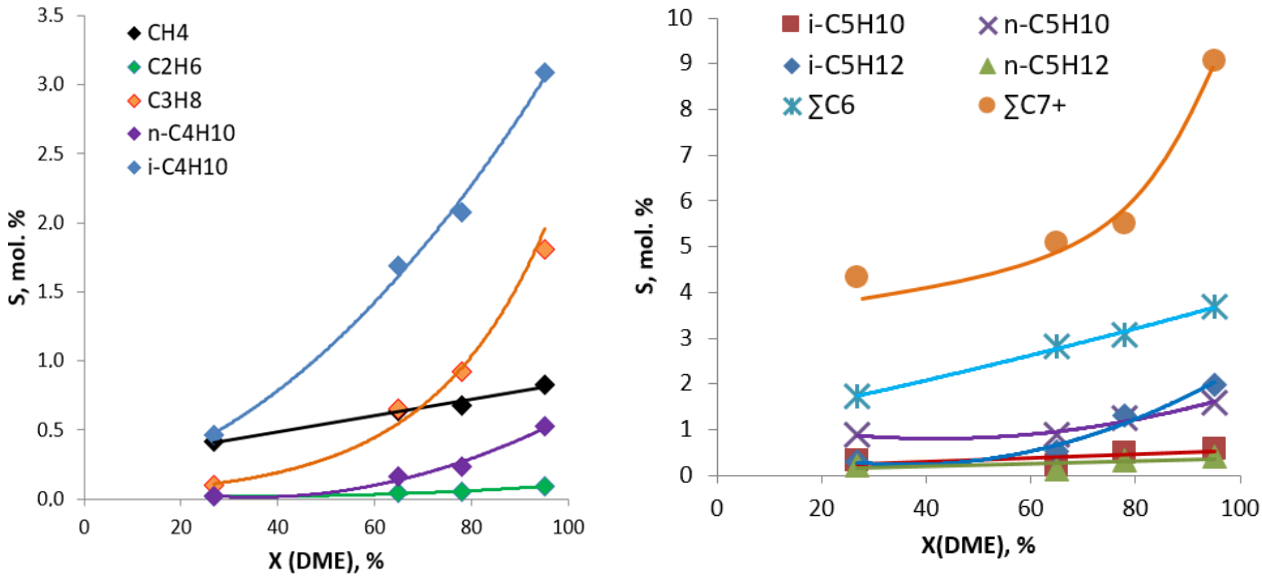


Fig. S7. The product distribution of C_1–C_4 alkanes (A) and C_5–C_8 hydrocarbons (B) over Mg-HZSM-5/Al_2O_3.

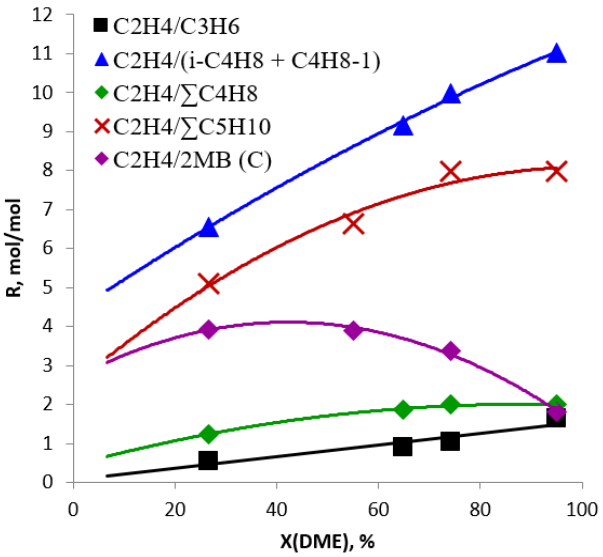


Fig. S8. The ratio of ethylene/alkenes C_3–C_5 (R) as a function of DME conversion (X(DME)) for the Mg-HZSM-5/Al_2O_3.
C_2H_4/2MB is the ratio of ethylene to sum of 2-methylbutane and 2-methyl-2-butene yield in carbon basis.

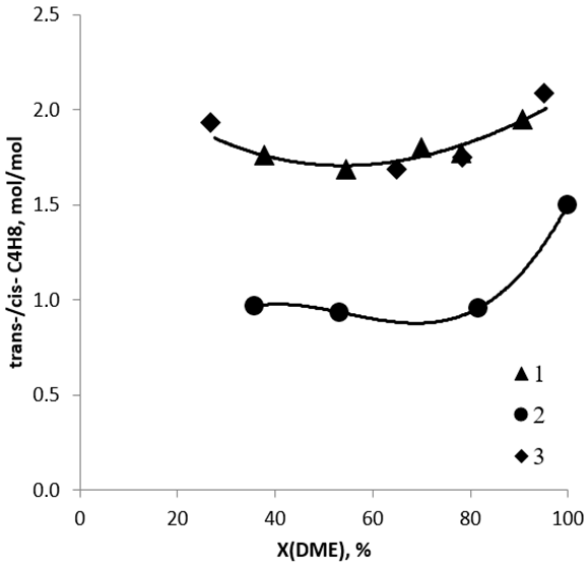


Fig. S9. Molar ratio of trans-/cis- C_4H_8 as a function of DME conversion (X(DME)).
1 – HZSM-5/Al_2O_3, 2 – Zr-HZSM-5/Al_2O_3, 3 – Mg-HZSM-5/Al_2O_3.

The isomerization rate was too high for Zr-modified sample, and the catalysts worked in the kinetic control zone of reaction. Therefore, butenes formed did not have time enough for isomerization into the trans-configuration.

Table S2. Products distribution for HZSM-5/Al_2O_3, Zr- and Mg- modified samples. Experimental data.

Product	**S, % mol.**				
	HZSM-5/Al_2O_3		**Zr-HZSM-5/Al_2O_3**		**Mg-HZSM-5/Al_2O_3**
	X=55%	**X=78%**	**X=53%**	**X=82%**	**X=78%**

CH_3OH	51.2	38.0	49.9	37.9	37.5
C_2H_4	12.7	17.5	13.1	17.8	18.5
C_3H_6	17.4	18.6	18.5	18.9	17.7
ΣC_4H_8	7.7	10.5	7.0	9.3	9.6
ΣC_5H_{10}	0.9	1.2	0.8	1.3	1.8
CH_4	0.5	0.6	0.4	0.5	0.8
C_2H_6	0.1	0.1	0.1	0.1	0.1
C_3H_8	0.3	0.8	0.3	0.6	0.8
ΣC_4H_{10}	1.0	2.7	1.0	2.6	2.4
ΣC_5H_{12}	0.5	1.3	0.8	1.6	1.7
ΣC_6	2.8	3.2	2.9	3.5	3.4
ΣC_{7+}	5.0	5.5	5.2	5.8	5.6

Table S3. The activation energy for the methylation reaction of olefins C_2 – C_4 and aromatics. Zeolite HZSM-5 (SiO_2 / Al_2O_3 = 45). Experimental data.

	Methylation agent	**Ea, kJ/mol**	**References**
Ethylene	Methanol	103-109	[*50, 51*]
	DME	94±3	[*39*]
Propylene	Methanol	69	[*50, 51*]
	DME	63±3	[*39*]
Butenes	Methanol	45	[*50, 51*]
	DME	44-56	[*39*]
Toluene	Methanol*	57-79	[*52*]
	DME	52±4	[*53*]
Xylene	Methanol*	25±5	[*52*]
	DME	62±4	[*55*]

*) for HZSM-5 with SiO_2/Al_2O_3=30

Table S4. Chemical reaction equations of conversion DME into hydrocarbons.

№	**Reaction**
Hydrocarbon pool formation	
1	$n(CH_3)_2O \rightarrow$ hydrocarbon pool (cyclopentenyl cations + methylbenzenes cations)
Methylation by DME	
2	$2(CH_3)_2O \rightarrow CH_3OH + C_3H_6 + H_2O$
3	$(CH_3)_2O + C_3H_6 \rightarrow C_4H_8 + CH_3OH$
4	$(CH_3)_2O + C_4H_8 \rightarrow C_5H_{10} + CH_3OH$
5	$(CH_3)_2O + C_5H_{10} \rightarrow C_6H_{12} + CH_3OH$
6	$(CH_3)_2O + C_6H_{12} \rightarrow C_7H_{14} + CH_3OH$
7	$(CH_3)_2O + C_7H_{14} \rightarrow C_8H_{16} + CH_3OH$
Creaking of higher olefins	
8	$C_8H_{16} \rightarrow C_3H_6 + C_5H_{10}$
9	$C_8H_{16} \rightarrow 2C_4H_8$
10	$C_7H_{14} \rightarrow C_3H_6 + C_4H_8$
Methylation polymethylbenzenes by methanol and subsequent dealkilation	
11	$n(CH_3)\text{-}C_6H_{6\text{-}n} + CH_3OH \rightarrow$ n-1$(CH_3)\text{-}C_6H_{6\text{-}n}\text{-}(C_2H_5) + H_2O$
12	n-1$(CH_3)\text{-}C_6H_{6\text{-}n}\text{-}(C_2H_5) \rightarrow$ n-1$(CH_3)\text{-}C_6H_{7\text{-}n} + C_2H_4$
H-transfer	

13	$2C_4H_8 \rightarrow C_4H_6 + C_4H_{10}$
14	$C_3H_6 + C_4H_8 \rightarrow C3H8 + C4H6$
15	$2C_4H_6 \rightarrow \text{cyclo-}C_6H_9\text{-}(C_2H_3) + 2\text{Zeolite} \rightarrow C_6H_5\text{-}(C_2H_5) + 2\text{Zeolite-H}$
16	$C_4H_6 + C_3H_6 \rightarrow \text{cyclo-}C_6H_9\text{-}(CH_3) + 4\text{Zeolite} \rightarrow C_6H_5\text{-}(CH_3) + 4\text{Zeolite-H}$
17	$C_3H_6 + 2\text{Zeolite-H} \rightarrow C_3H_8 + 2\text{Zeolite}$
18	$C_4H_8 + 2\text{Zeolite-H} \rightarrow C_4H_{10} + 2\text{Zeolite}$
19	$C_5H_{10} + 2\text{Zeolite-H} \rightarrow C_5H_{12} + 2\text{Zeolite}$
20	$C_6H_{12} + 2\text{Zeolite-H} \rightarrow C_6H_{14} + 2\text{Zeolite}$
21	$C_7H_{14} + 2\text{Zeolite-H} \rightarrow C_7H_{16} + 2\text{Zeolite}$
Isomerization	
22	$n\text{-}C_4H_8 \rightarrow i\text{-}C_4H_8$
23	$n\text{-}C_5H_{10} \rightarrow i\text{-}C_5H_{10}$
24	$n\text{-}C_6H_{12} \rightarrow i\text{-}C_6H_{12}$
25	$n\text{-}C_7H_{14} \rightarrow i\text{-}C_7H_{14}$