Supplementary Material for

Resistance against Carbon Deposition via Controlling Spatial Distance of Catalytic Components in Methane Dehydroaromatization

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KEYWORDS: spatial distance; molybdenum; HMCM-22; carbon deposition; methane dehydroaromatization

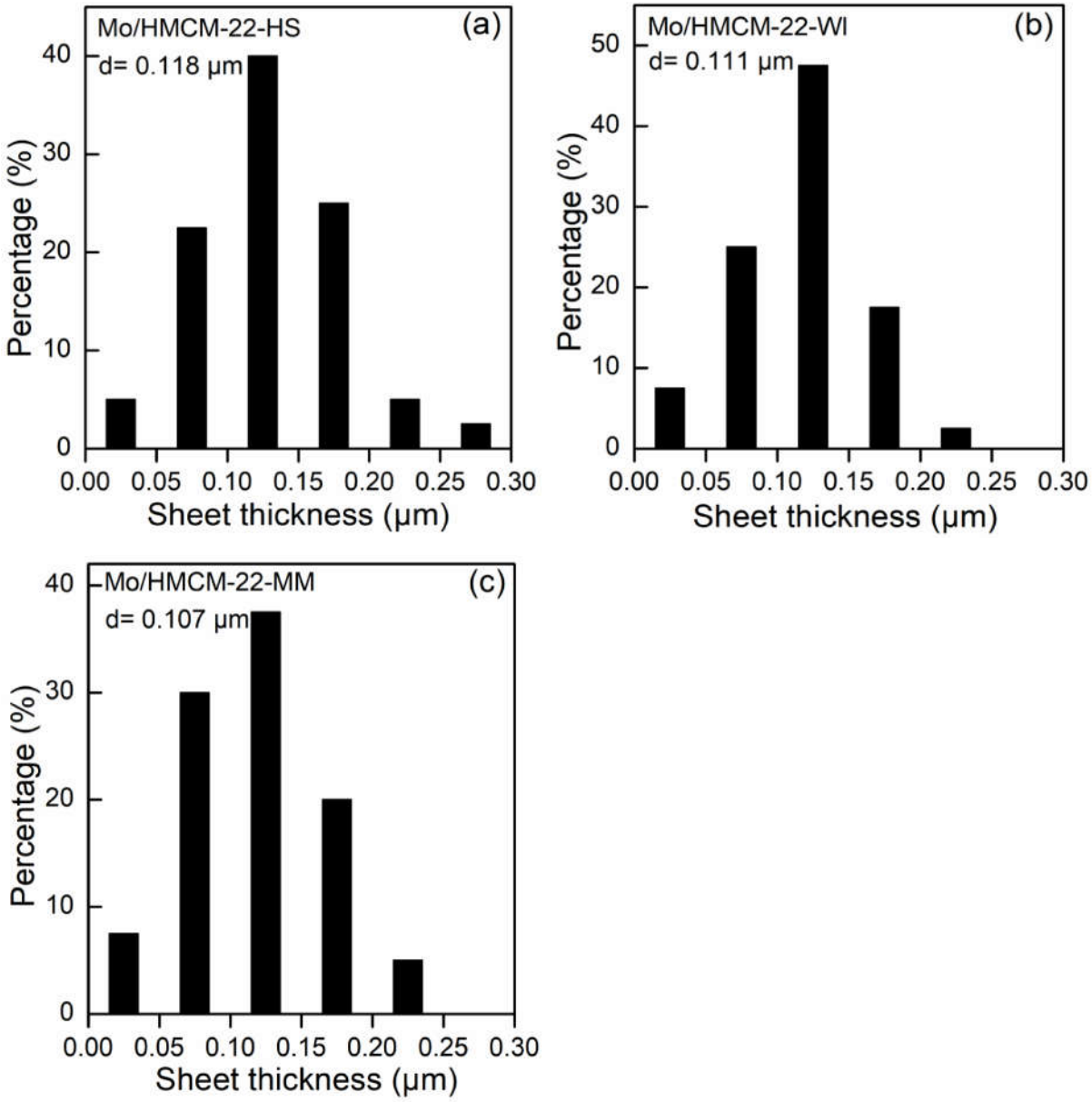

Figure S1. The size distribution of sheet thickness for the Mo/HMCM22-HS, Mo/HMCM22-WI and Mo/HMCM22-MM. (a) Mo/HMCM22-HS; (b) Mo/HMCM22-WI; (c) Mo/HMCM22-MM. Statistical analysis of the thickness distribution was based on 100 sheets for each sample. The average sheet thickness of Mo/HMCM-22-HS, Mo/HMCM-22-WI and Mo/HMCM-22-MM was about 0.118, 0.111 and 0.107 μm, respectively.

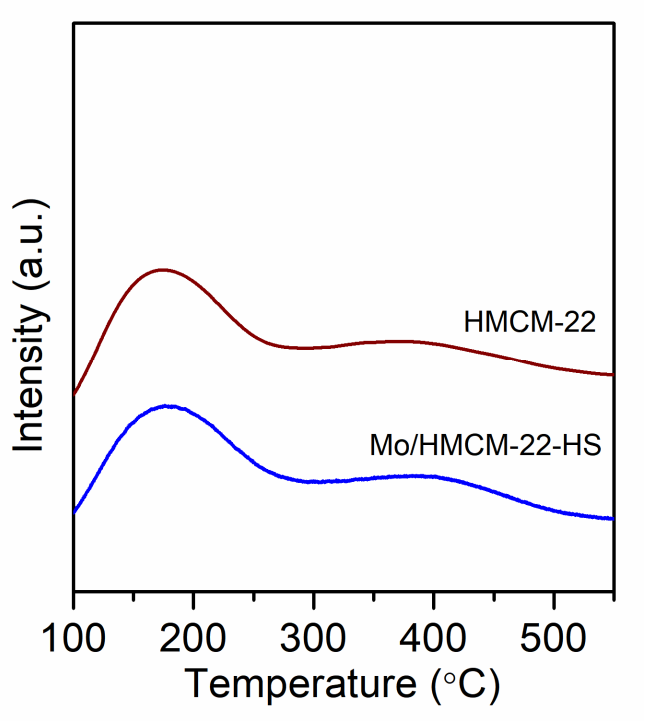

Figure S2. NH_3-TPD analyses for the HMCM-22 zeolite and Mo/HMCM-22-HS catalyst.

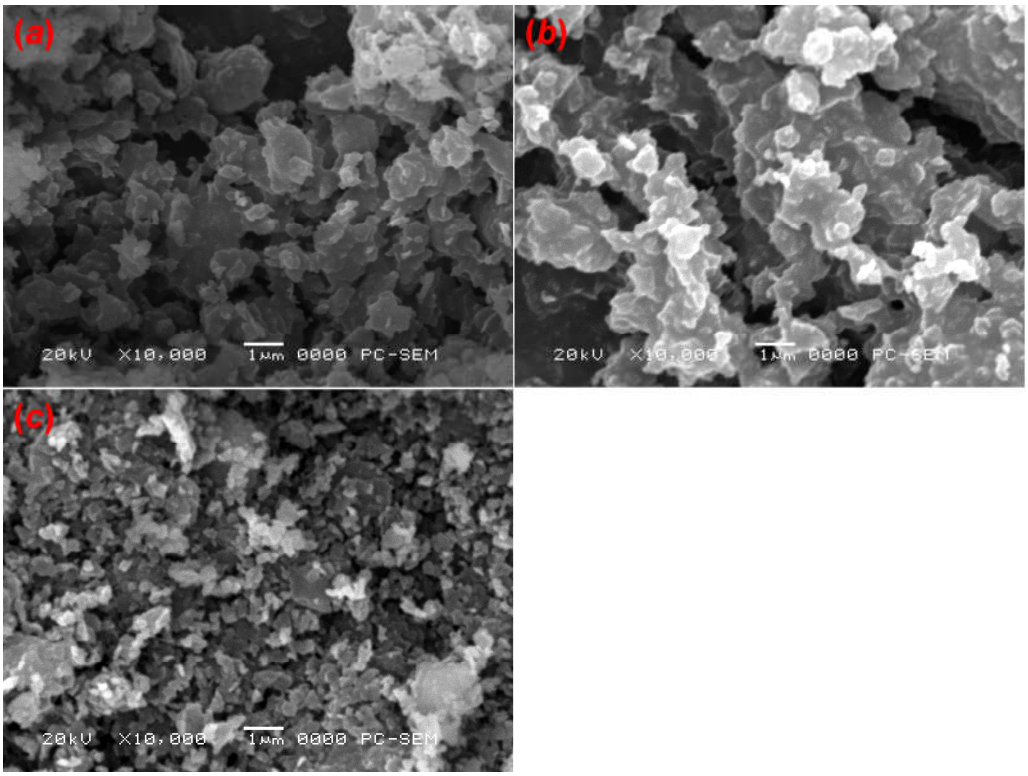

Figure S3. SEM images for the spent catalysts of Mo/H-MCM-22-HS, Mo/H-MCM-22-WI and Mo/H-MCM-22-MM.

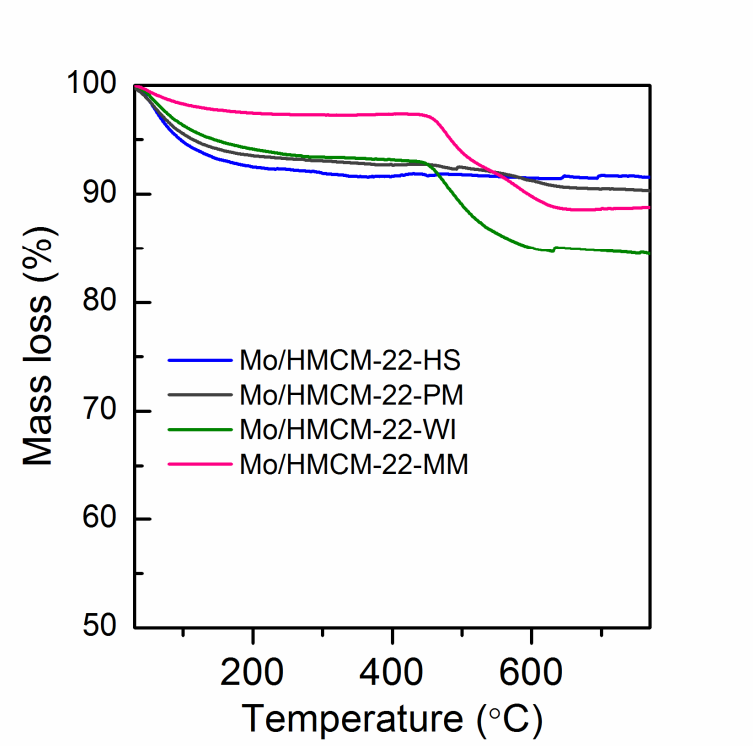

Figure S4. TG analysis for the spent catalysts of Mo/H-MCM-22-HS, Mo/H-MCM-22-PM, Mo/H-MCM-22-WI and Mo/H-MCM-22-MM.

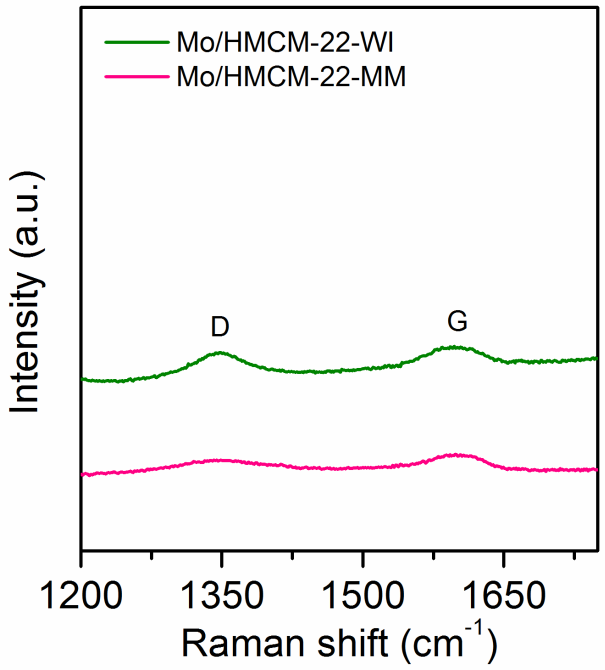

Figure S5. Raman analysis for the spent catalysts of Mo/H-MCM-22-WI and Mo/H-MCM-22-MM.

The G band is assigned to the first-order scattering of the E_{2g} mode of sp^2 carbon domains, arising from the C-C bond stretching of graphitic materials. The D band is assigned to a disordered structure of graphene [1-4].

Table S1 Average distance between Mo species and acid sites for Mo/HMCM-22 catalysts.

Sample	Average distance (μm)
Mo/H-MCM-22-HS[a]	9.0×10^{-3}
Mo/HMCM-22-WI[b]	5.6×10^{-2}
Mo/HMCM-22-MM[c]	1.0×10^{-1}
Mo/HMCM-22-PM[d]	6.0×10^{2}
Mo/HMCM-22-DCB[e]	1.5×10^{4}

(a) The average distance was calculated based on uniform distribution of Mo particles in the HMCM-22 zeolite. (b) The average distance was obtained according to the average sheet thickness of Mo/HMCM-22-WI (Fig S1b). (c) The average distance was calculated on the ground of the average sheet thickness of Mo/HMCM-22-MM (Fig S1c) and the size of MoO_3 particles (~100 nm, purchased from Sigma-Aldrich Co., LLC.). (d) The average distance was evaluated on the basis of the particle sizes of HMCM-22 zeolite (20~40 mesh) and MoO_3 (20~40 mesh). (e) The average distance was evaluated based on the bed distance of HMCM-22 zeolite and MoO_3 particles in the quartz reactor.

Table S2 Textural properties for the HMCM-22 zeolite and Mo/H-MCM-22 catalysts.

Sample	S_{BET}[a] ($m^2\ g^{-1}$)	V_{total}[b] ($cm^3\ g^{-1}$)	V_{micro}[c] ($cm^3\ g^{-1}$)	V_{meso}[d] ($cm^3\ g^{-1}$)
HMCM-22	503.3	0.68	0.17	0.51
Mo/H-MCM-22-HS	298.5	0.51	0.11	0.40
Mo/HMCM-22-WI	315.3	0.56	0.11	0.45
Mo/HMCM-22-MM	364.4	0.51	0.14	0.37
Mo/HMCM-22-PM	424.5	0.70	0.15	0.55

(a) BET surface area, (b) total volume of pores from single point adsorption, (c) t-plot micropore volume, (d) mesopore volume (V_{meso}) = V_{total} - V_{micro}.

References

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