Mesoporous Zr-Beta zeolite prepared by post-synthetic strategy as a robust Lewis acid catalyst for the ring-opening aminolysis of epoxides

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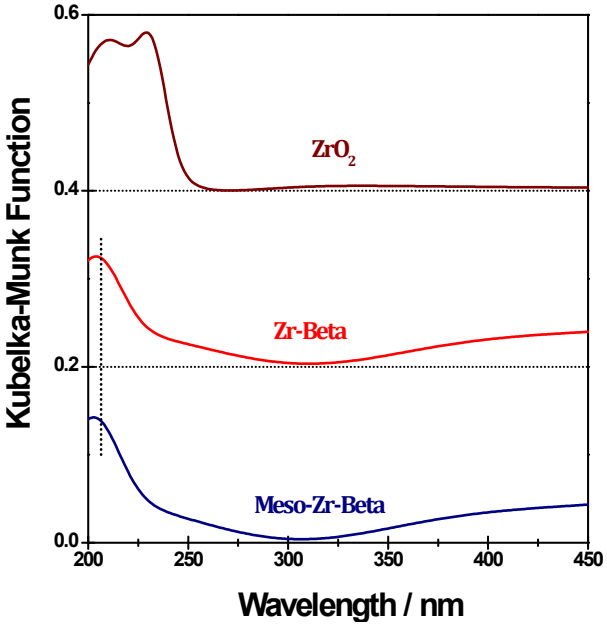

Figure S1 UV-vis spectra of Zr-Beta and Meso-Zr-Beta samples.

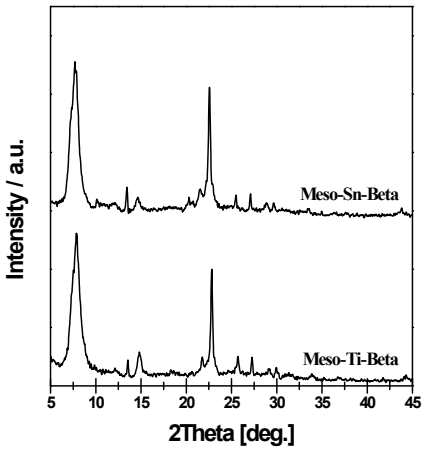

Figure S2 XRD patterns of Meso-Ti-Beta and Meso-Sn-Beta samples.

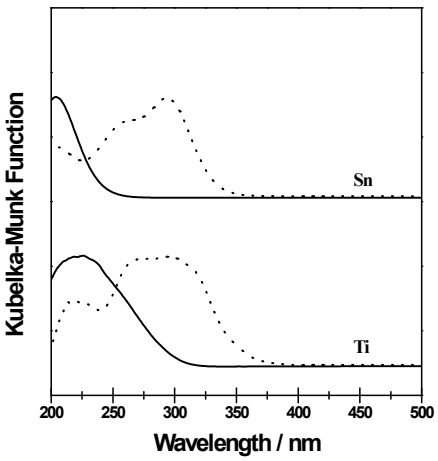

Figure S3 UV-vis spectra of Meso-Ti-Beta and Meso-Sn-Beta samples. UV-vis spectra of corresponding bulk metal oxides SnO_2 and anatase TiO_2 are shown in dashed lines for reference

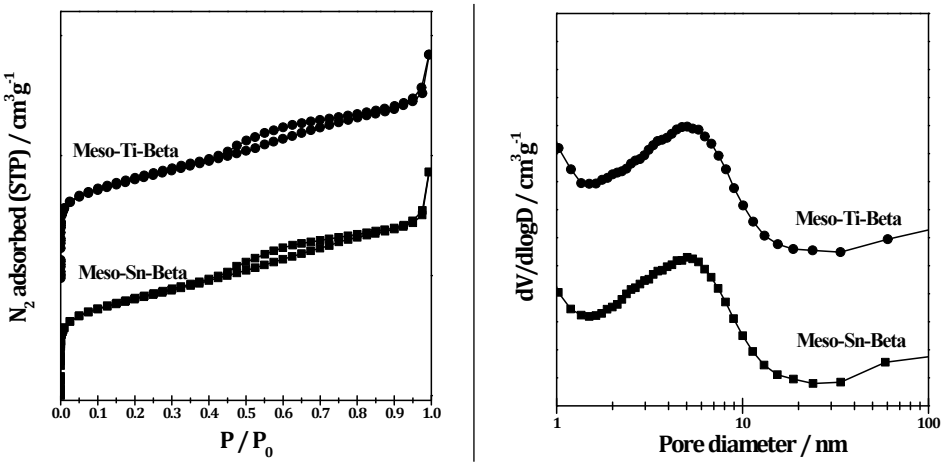

Figure S4 N_2 adsorption/desorption isotherms and pore diameter distribution of Meso-Sn-Beta and Meso-Ti-Beta

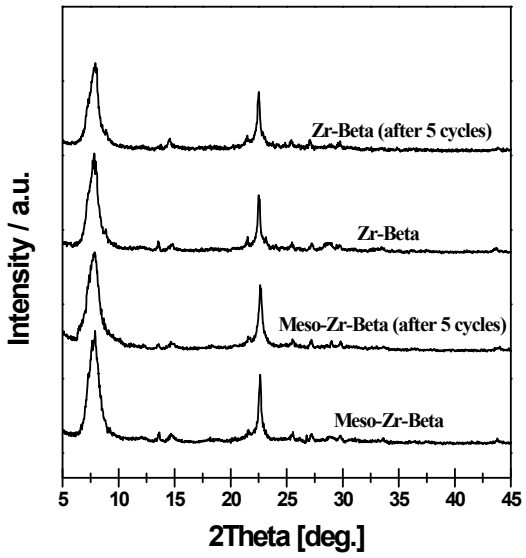

Figure S5 XRD patterns of fresh and reused Zr-containing silicates samples.

Table S1 Comparison between the catalytic activity of the ring-opening aminolysis of styrene oxide with aniline over various catalysts [a]

Catalyst [b]	Temperature / Time	Styrene oxide Conv. (%)	Product select. (%)	TON ($mol_{Epo}mol_{M}^{-1}$)	Average TOF (h^{-1})	Ref.
TS-1 (30)	308K / 6h	39.1	88.1	312	52	[39]
Ti-MCM-41 (30)	308K / 6h	92	95.8	726	121	[39]
Ti-SBA-15 (30)	308K / 6h	90.2	92.1	654	109	[39]
Ti-SBA-12 (30)	308K / 6h	93.7	92.9	882	147	[39]
Ti-SBA-16 (30)	308K / 6h	86.9	93.5	936	156	[39]
Zr-ZSM-5 (50)	318K / 5min	26	96	195	2340	[40]
Ti-Nano(PrTES)-ZSM-5 (50)	318K / 5min	8	92	58	695	[40]
Ti-Nano(TPHAC)-ZSM-5 (50)	318K / 5min	8	91	56	677	[40]
Zr-Nano(PrTES)-ZSM-5 (50)	318 K / 5 min	83	96	587	7040	[40]
Zr-Nano(TPHAC)-ZSM-5 (50)	318K / 5min	79	94	566	6790	[40]
Zr-Beta (100)	308K / 0.5h	40.5	94.4	486	972	this study
Meso-Sn-Beta (100)	308K / 0.5h	41.0	91.1	492	984	this study
Meso-Ti-Beta (100)	308K / 0.5h	56.6	92.4	679	1358	this study
Meso-Zr-Beta (100)	308 K / 0.5 h	80.7	94.7	968	1936	this study
Meso-Zr-Beta (100)	318K / 5min	67.5	95.8	810	9720	this study

[a] Reaction conditions: n(epoxide) / n(amine) = 1:1; [b] Values in parentheses indicate the Si/Al molar ratio of catalysts.

Table S2 Physicochemical properties of Zr-silicate zeolites.

Sample	n_{Si}/n_{Zr} [b]	Surface area (m^2g^{-1}) [c]
Zr-Beta	97.3	600
Meso-Zr-Beta	97.0	720
Zr-Beta [a]	96.9	437
Meso-Zr-Beta [a]	97.1	715

[a] After five cycles; [b] Determined by ICP;

[c] Determined by nitrogen adsorption