Supplementary Materials: Chromium Oxide Supported on Silicalite-1 Zeolite as a Novel Efficient Catalyst for Dehydrogenation of Isobutane Assisted by CO₂

Figure 1. SAXS patterns of SBA-15 and 3%Cr/SBA.

(a) 3%Cr/S-I

(b) 3%Cr/SBA

500 nm

Cr

Cr
Figure S2. HAADF STEM images (left) and corresponding EDX elemental mapping of Cr (right). (a) 3%Cr/S-1; (b) 3%Cr/SBA.

Figure S3. XPS spectra of Cr 2p on the fresh and spent 3%Cr/S-1 and 3%Cr/SBA catalysts. (a) fresh 3%Cr/S-1; (b) 3%Cr/S-1 after isobutane dehydrogenation in the presence of CO$_2$ at 570 °C for 6 h; (c) 3%Cr/S-1 after isobutane dehydrogenation in the absence of CO$_2$ (i.e. using N$_2$ instead of CO$_2$) at 570 °C for 6 h; (d) 3%Cr/S-1 after isobutane dehydrogenation in the absence of CO$_2$ at 570 °C for 6 h, followed by treatment with CO$_2$ at 570 °C for 0.5 h; (e) fresh 3%Cr/SBA; (f) 3%Cr/SBA after isobutane dehydrogenation in the presence of CO$_2$ at 570 °C for 6 h. Reaction conditions: 570 °C, 0.1 g catalyst, CO$_2$ (N$_2$)/i-C$_4$H$_{10}$ = 1 (mol/mol), WHSV = 4.1 h$^{-1}$. 
Figure S4. $^{29}$Si MAS NMR spectra of (a) silicalite-1, (b) 3%Cr/S-1, (c) SBA-15 and (d) 3%Cr/SBA.

Figure S5. The effect of content of Cr in the Cr/S-1 catalysts on the initial conversion of isobutane and initial product selectivity. Reaction conditions: 570 °C, 0.1 g catalyst, CO$_2$/i-C$_4$H$_{10}$ = 1 (mol/mol), WHSV = 4.1 h$^{-1}$.
Figure S6. The results of the reverse water gas shift reaction over the Cr/S-1 catalysts at 570 °C. (■) 0.5%Cr/S-1; (●) 1%Cr/S-1; (▲) 2%Cr/S-1; (▼) 3%Cr/S-1; (●) 7%Cr/S-1. Reaction conditions: 0.1 g catalyst, CO₂/H₂ = 1 (mol/mol), 2.9 mL/min of CO₂.

Figure S7. NH₃-TPD profiles of (a) 3%Cr/SBA and (b) 3%Cr/S-1.
Figure S8. TPO profiles of both spent 3%Cr/S-1 and 3%Cr/SBA catalysts. Reaction conditions are the same as given in caption to Figure S5.

Figure S9. (a) SAXS patterns of 3%Cr/SBA and (b) XRD patterns of 3%Cr/S-1 before and after isobutane dehydrogenation assisted by CO₂. Reaction conditions are the same as given in caption to Figure S5.