

NiO Promoted CuO-NiO/SBA-15 Composites as Highly Active Catalysts for
Epoxidation of Olefins

Yinhai Tang, Hongyi Gao, Mu Yang*, Ge Wang*, Jie Li, Huan Zhang, Zhang Tao

Beijing Key Laboratory of Function Materials for Molecule & Structure Construction,
School of Materials Science and Engineering, University of Science and Technology
Beijing, Beijing 100083, People's Republic of China

* Corresponding author. Tel.: +86-10-62333765;

E-mail address: yangmu@ustb.edu.cn; gewang@mater.ustb.edu.cn;

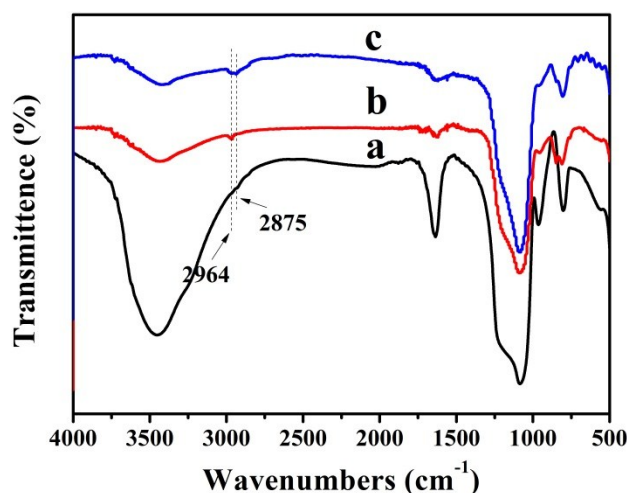


Fig. S1. FT-IR spectra of (a) SBA-15, (b) -CH₃ modified SBA-15 and (c) -CH₃ and -NH₂ modified SBA-15.

As shown in Fig. S1, in comparison with pure SBA-15 (Fig. S1a), -CH₃ modified on the exterior surface of SBA-15 (Fig. S1b) shows a new absorption peaks at around 2964 cm⁻¹. This is attributed to C-H asymmetric stretching modes of -CH₃ from trimethylchlorosilane (TMCS), indicating the well grafting of -CH₃. The -CH₃ and -NH₂ modified SBA-15 (Fig. S1c) shows a new absorption peaks at about 2875 cm⁻¹, which belongs to the asymmetric stretching modes of -CH₂- from 3-aminopropyltriethoxysilane (APTES). This indicates the successful grafting of -NH₂ on SBA-15.

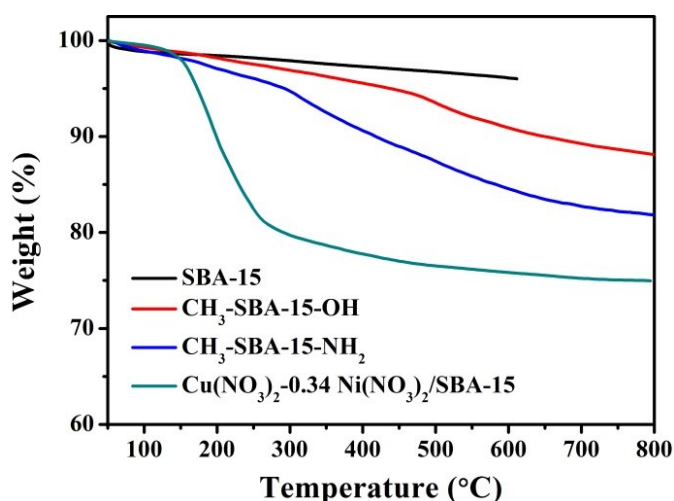


Fig. S2. TGA curves of SBA-15, CH₃-SBA-15-OH, CH₃-SBA-15-NH₂ and Cu(NO₃)₂-0.34 Ni(NO₃)₂/CH₃-SBA-15-NH₂.

TGA curves of the -CH₃ modified SBA-15 and the -CH₃ and -NH₂ modified SBA-15 were obtained and shown in Fig. S2. The pure SBA-15 shows a weight loss at about 3.6 wt%, which is due to the remove of absorbed water and the condensation of silanol groups. The -CH₃ modified SBA-15 (CH₃-SBA-15-OH) shows a weight loss at about 11.8 wt%, and the -CH₃ and -NH₂ modified SBA-15 (CH₃-SBA-15-NH₂) shows a weight loss at about 18.2 wt%. So the quantity of -CH₃ and aminopropyl groups are about 8.2 wt% and 6.4 wt%, respectively.

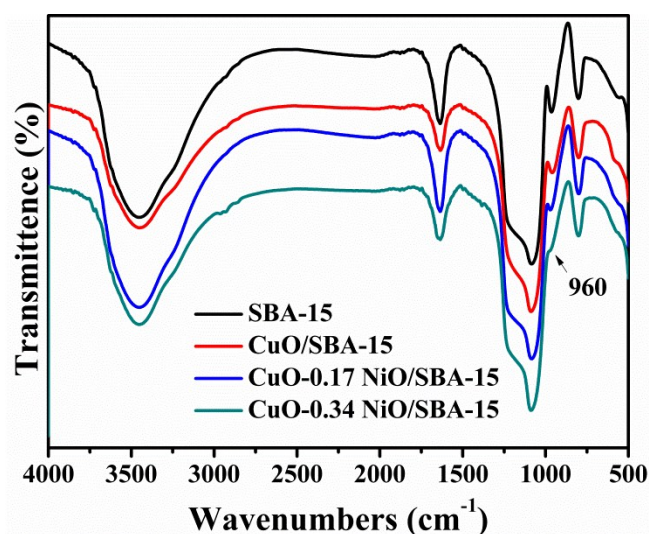


Fig. S3. FT-IR spectra of SBA-15 and CuO-x NiO/SBA-15 (x = 0, 0.17 and 0.34).

After calcination, the organic groups were removed. The band around 960 cm⁻¹ can be attributed to Si-O vibration in Si-OH groups in SBA-15, which slightly declines and finally disappears on the CuO-x NiO/SBA-15 (x = 0, 0.17 and 0.34), suggesting that CuO and NiO load dispersedly in the channels via bonding with silanols.

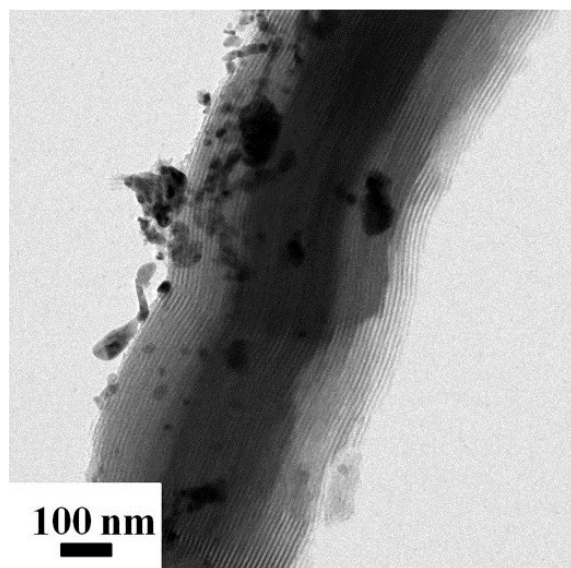


Fig. S4. HRTEM image of CuO/SBA-15 using SBA-15 without modification.

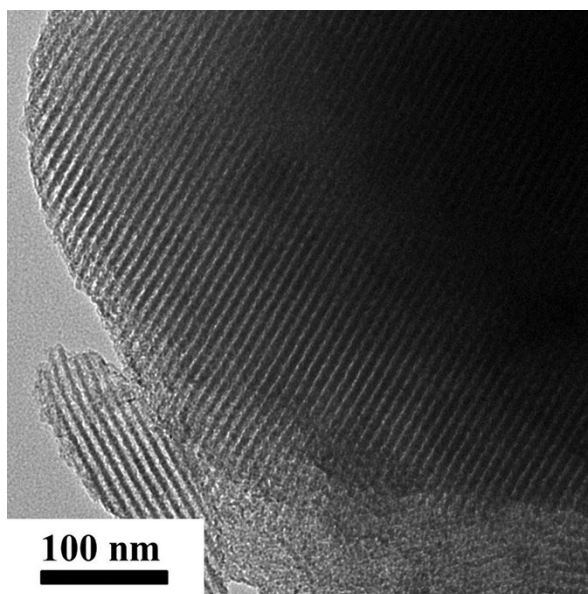


Fig. S5. HRTEM image of NiO/SBA-15.