Insight into the hydrothermal stability of mesostructured cellular silica foams

Qiang Li, Bo Tu and Dongyuan Zhao

Department of Chemistry, Advanced Materials Laboratory, Fudan University, Shanghai, 200433, P. R. China

E-mail address: dyzhao@fudan.edu.cn

The mesostructured cellular silica foams (MCFs) is a kind of promising catalytic materials especially for bulky molecular reaction [1-2]. However, the hydrothermal stability of mesoporous materials is an important factor limiting the extensive industrialized application [3-4]. Here, the hydrothermal stability of MCFs was investigated detailedly for the first time. It was characterized using transmission electron microscopy (TEM), nitrogen sorption, ^{29}Si solid-state nuclear magnetic resonance (^{29}Si NMR) and Fourier transform infrared (FT-IR). We found more micropores and "round-like" pores contribute to the stability of MCFs prepared at 550 ^{o}C in high temperature steam. During the initial 3 h steam treatment in 600 ^{o}C, many specific surface area and pore volume were lost. Simultaneously, the polymerization degree of ≡Si-O-Si≡ linkage was largely enhanced and the framework of MCFs prepared at 550 ^{o}C became more "stout". After this treatment, the change of the structural parameter of MCFs was slight with the elongation of the steamed time. The framework of MCFs prepared at 550 ^{o}C can not withstand the more critical condition of 800 ^{o}C steam and collapsed completely. By elevating the calcination temperature of MCFs to 900 ^{o}C, the polymerization degree of framework was further enhanced. Hence, it exhibited high hydrothermal stability under the steam of 800 ^{o}C. When the steam treatment was prolonged, the specific surface area and pore volume decrease gradually, but the mesostructure of MCFs was well-retained. Furthermore, we found that the variation characteristics between MCFs and SBA-15 [3] were distinct under the high temperature steam. We make a qualitative illustration on the discriminating phenomena from the thermodynamic standpoint.

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