Extremely stable zeolites developed via liquid-mediated self-defect-healing

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The successful application of zeolites in diverse fields largely relies on their high stability compared with other porous materials. However, the property requirements for zeolites have become stringent due to their diverse and demanding applications. Aluminosilicate zeolites are utilized for adsorptive and catalytic applications, wherein they are sometimes exposed to high-temperature steaming conditions (~1000 °C). Zeolites are exposed to severe steaming conditions in regenerators to remove coke, and over 400,000 t/y of catalysts are discarded due to degradation during the FCC process [1]. Recently, zeolites have been used in exhaust gas treatment processes, such as the selective catalytic reduction of NOx, catalytic oxidation for diesel engines, and hydrocarbon trapping [2], wherein they degrade due to interactions with high-temperature (>800 °C) steam. In automotive applications, degradation is often severe because zeolites are continuously exposed to steam without replacement. Therefore, the development of highly stable zeolites has become an important issue. As the degradation of high-silica zeolites originates from the defect sites in their frameworks, feasible defect-healing methods are highly demanded. Herein, we propose a method for healing defects to create extremely stable high-silica zeolites. High-silica (SiO_2/Al_2O_3 > 240) zeolites with *BEA-, MFI-, and MOR-type topologies could be stabilized by significantly reducing the defect sites via a liquid-mediated treatment without using additional silylating agents. Upon exposure to extremely high-temperature (900–1150 °C) steam, the stabilized zeolites retain their crystallinity and micropore volume, whereas the parent commercial zeolites degrade completely (Figure 1). The proposed self-defect-healing method provides new insights into the migration of species through porous bodies and significantly advances the practical applicability of zeolites in severe environments.

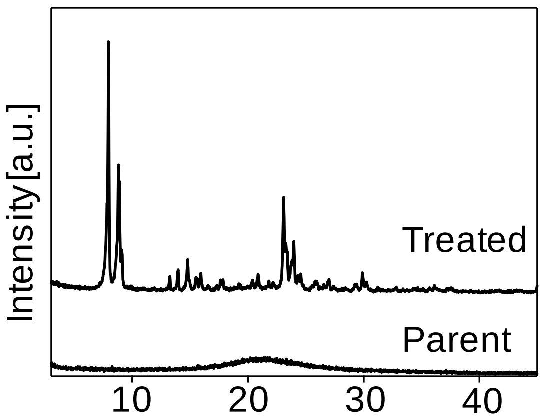

Figure 1 XRD patterns of MFI-type zeolite after 1150 °C steaming for 3 hours.

Reference
[1] H. S. Cerqueira, et al., J. Mol. Catal. A: Chem. 292, (2008) 1–13.
[2] A. M. Beale, et al., Chem. Soc. Rev. 44, (2015) 7371–7405.