Study of Bimetallic ZIF Structures for Adsorption Iodine and Clorine by XANES

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Introduction

Zeolite imidazolate frameworks (ZIFs) have unique structural properties and unexpected thermal and chemical stability [1]. Widespread application of ZIFs is associated with gas sorption and storage, primarily due to a porous ZIFs structure. Recently was shown that ZIF-8 could be effectively used for a sorption of iodine, which is a volatile gaseous fission product [2]. Because elemental halogens play an important role in the industry, but they are toxic and volatile, it is an important research task to develop reliable methods for safe handling, storage, and transportation [3]. In this study we show application of bimetallic $Zn_{1-x}Co_xC_8H_{10}N_4$ ZIFs structures for sorption I_2 and Cl_2.

Experimental methods

In this study we synthesized $Zn_{1-x}Co_xC_8H_{10}N_4$ (x = 0.05, 0.25, 0.75) samples from zinc nitrate hexahydrate, cobalt nitrate hexahydrate and 2-methylimidazole by using microwave radiation as described in [4]. The crystal structure of $Zn_{1-x}Co_xC_8H_{10}N_4$ samples were characterized by means of powder X-ray diffraction (XRD) using Bruker D2 Phaser diffractometer (Cu k_α, λ=1.5406 Å). The experimental Co K-edge (7709 eV) and Zn K-edge (9659 eV) XANES spectra were measured using in-house X-ray spectrometer Rigaku R-XAS Looper for samples before and after interaction with I_2 and Cl_2.

Results and discussion

The comparison of the XRD patterns for $Zn_{1-x}Co_xC_8H_{10}N_4$ samples before and after interaction with I_2 shows that the structure of samples does not changes. XANES absorption spectra of the Zn and Co K-edges for bimetallic $Zn_{1-x}Co_xC_8H_{10}N_4$ have no any shifts of white line due to changes in oxidation state of metallic atoms. The shape of spectra before and after interaction with I_2 is similar. This fact gives us opportunity to conclude that I_2 does not cause changes in ZIFs structure and sorbed into their pores. On the contrary, the XRD and XANES data for the $Zn_{1-x}Co_xC_8H_{10}N_4$ samples interacted with Cl_2 confirm the presence of the structural changes. This may be caused by the bond formation between chlorine atoms and linkers in the ZIF structure.

Conclusions

In present work the bimetallic ZIFs $Zn_{1-x}Co_xC_8H_{10}N_4$ (x = 0.05, 0.25, 0.75) samples were synthesized. Using XRD and XANES techniques the structure of $Zn_{1-x}Co_xC_8H_{10}N_4$ samples before and after interaction with volatile I_2 and Cl_2 were studied.

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References
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