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Application of metal-organic framework material in hydrogen isotope chromatographic separation and analysis

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Hydrogen isotope separation is among the key technological problems, in the utilization of nuclear fusion energy and moreover, in gas atmosphere in the process flow of ITER fuel cycle it is more than complexity. Thus, making effective separation and analysis of hydrogen isotopic mixtures is necessary and an urgent task to be addressed. As hydrogen isotopes share almost identical shape, size and chemical properties, separating and analyzing of hydrogen isotopes is really not an easy task. In this letter, ultralow temperature separation of H_2/D_2 mixture through quantum sieving was experimentally examined on two metal-organic framework (MOF) materials, with an extreme two-dimensional confinement formed within the material of {[Fe(OH)(H_2bta)](H_2O)}n experienced by hydrogen molecules, an extraordinary separation factor of H_2/D_2 as high as 41.4±0.4 at 20 K was finally experimentally obtained. Furthermore, MOF material CPL-1 ([Cu_2(pzdc)$_2$(pyz)]n) was further tested as the stationary phase of gas chromatography for the analysis of H_2/HD/D_2 mixtures with a large specific surface area and uniform pore size, CPL-1 showed a better adsorption of H_2/D_2 in capacity than that of $MnCl_2$@γ-Al_2O_3 and γ-Al_2O_3 and CPL-1 packed column showed more rapidly in signal detection, i.e., less retention time, than that of $MnCl_2$@γ-Al_2O_3 toward H_2/HD/D_2 under a condition of 77 K and carrier gas (Ne) flow rate of 3ml/min. With a sampling volume of 0.25~2.0 ml, GC with CPL-1 packed column showed good linear respondence toward measurement of H_2/HD/D_2 mixtures with mean relative error less than 4%, showing promising potential use of MOF material in hydrogen isotope chromatographic analysis.

Biography

Dawei Cao is a PhD student under the supervision of Prof. Shuming Peng in China Academy of Engineering Physics and Prof. Zhengjun Zhang in Tsinghua University. He completed his Graduate degree from Amoy University in 2012. His current research concentrates on the separation and analysis of hydrogen isotopes.

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