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ORIGINAL PAPER

Porous aromatic frameworks of co-cured diethynylbenzene (DEB) and vinyltrimethoxysilane (VTMS) with good thermo-oxidative stability

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Abstract A series of new porous aromatic frameworks (PAA-VTMS) co-cured by diethynylbenzene (DEB) and vinyltrimethoxysilane (VTMS) have been described. Thermally treated PAA-VTMS were also investigated. When the ratio of DEB to VTMS was 1:1 (PAA-VTMS-4), it showed characteristic pores with uniform diameter, confirmed by scanning electron microscope (SEM) and transmission electron microscopy (TEM) analyses. The surface area of PAA-VTMS-4 was up to 457 m^2/g and its pore size was 7 nm, related to the hyper-cross-linked structure with plentiful benzene units. The co-cured PAA-VTMS samples whose DEB/VTMS ratios were higher or less than 1:1 showed low surface area. CO_2 uptake of PAA-VTMS-4 was 83 cm^3/g at 0 °C and 72 cm^3/g at 25 °C. The temperature of 5% weight loss of PAA-VTMS-4 was 388 °C in nitrogen and 346 °C in air. The surface area of the thermally treated sample (OPAA-VTMS-4) was decreased, but its CO_2 uptake was as high as 115 cm^3/g at 0 °C and 105 cm^3/g at 25 °C. The OPAA-VTMS-4 sample almost did not decompose in N_2, and the temperature of its 5% weight loss was 450 °C in air. It showed that PAA-VTMS with its new porous aromatic framework can be used at high temperature.

Keywords Porous aromatic framework · Diethynylbenzene · Vinyltrimethoxysilane · Co-curing · Adsorption

Introduction

World environment and climate are now strongly affected by greenhouse gases because of anthropogenic emissions. Thus, capture and storage of carbon dioxide is a potential strategy to reduce the global warming [1, 2]. Porous organic frameworks (POFs) are good gas storage media, which are current concerns in clean energy and environment. POFs have different chemical compositions and structures via robust covalent bonds, including common poly(styrene-*co*-divinylbenzene) [3, 4], polyanilines [5], polypyrroles [6], poly(arylenevinylene) [7] and networks of aromatic rings [8–10]. POFs have good mechanical stability, high surface area, and controlled surface functionality and their design and synthesis show progress. These new POFs have wide applications in the fields of the molecular separation [11, 12], gas storage [13], catalysis [14], opto-active materials and sensors [15, 16], etc.

Another type of cross-linked POFs was derived from acetylene-type monomers [17], such as DEB (diethynylbenzene) which can form a kind of polycyclotrimer (polyarylacetylene). Porous aromatic frameworks (PAFs) contain plentiful phenyl rings, which are provided by polyphenylene, triethynylbenzene or other polymerization process [18]. For this network skeleton [19], PAFs has a high value of Brunauer–Emmett–Teller (BET) surface area. Hanková et al. [20] synthesized long-chain conjugated networks (the polyene main chains) by Rh-catalyzed coordination polymerization of 1,3-diethynylbenzene or 1,4-diethynylbenzene, whose surface area was up to 809 m^2/g and hydrogen uptake (a_{H2}) was

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