Facile Synthesis of Ultramicroporous Carbon Adsorbents with Ultra-high CH4 Uptake by In Situ Ionic Activation

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Abstract

We introduce a straightforward method for the preparation of novel starch-based ultramicroporous carbons (SCs) that demonstrate high CH4 uptake and excellent CH4/N2 selectivity. These SCs are derived from a combination of starch and 1-6 wt. % of acrylic acid, and the resulting materials are amenable to surface cation exchangeability as demonstrated by the formation of highly dispersed K+ in carbon precursors. Following activation, these SCs contain ultramicropores with narrow pore-size distributions of <0.7 nm, leading to porous carbon-rich materials that exhibit CH4 uptake values as high as 1.86 mmol/g at 100 kPa and 298 K, the highest uptake value for CH4 to date, with the IAST-predicted CH4/N2 selectivity up to 5.7. Both the potential mechanism for the formation of narrow pores and the origin of the favorable CH4 adsorption properties are discussed and examined. This work may potentially guide future designs for carbon-rich materials with excellent gas adsorption properties.

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