



Contribution ID: 58

Type: Oral Presentation

Structure characterization-mediated designing of novel carbon-based nanostructured materials

Wednesday, May 22, 2024 8:30 AM (30 minutes)

Carbon has outstanding physical properties such as high electrical conductivity and excellent mechanical strength and chemically and physically robustness. The nanostructured carbon such as nanoporous carbons, single wall carbon nanotube (SWCNT) and graphenes have promising potentials for giving solutions to the global warming issue. This presentation introduces the importance of structural characterization in the following four key topics

The supercapacitors using ionic liquid(IL)s can realize very high energy density. The structure of ionic liquid, EMI-TFSI, in 0.7 nm pores of carbide-derived carbon was studied with HRMC simulation-aided X-ray scattering. We evidenced the partial breaking of Coulombic law for the assembly structure of IL ions¹.

The ambient pressure storage of high density methane in nanoporous carbons enables to develop convenient methane cartridges irrespective of the severe difficulty². We coated nanoporous carbon with graphenes which have a thermally switchable valve function. The nanographene valves open at 473 K and close at ambient temperature³. The stored methane of large amount can be stably stored for two weeks at least.

The mechanical energy storage using multi-wall carbon nanotube was reported by Baughman et al⁴. However, their stored energy is not necessarily remarkable. We prepared the SWCNT ropes which have the gravimetric energy density (GED) of up to 2.1 MJ kg⁻¹ exceeding by over four orders of magnitude that of mechanical steel springs and by a factor of 3 that of advanced LIBs in addition to the low temperature stability⁵.

Ultrafast-permeable graphene-wrapped crystal membranes which give an excellent separation ability, as evidenced by marked upward-deviation from the upper bound of Robeson plot for H₂/CH₄. The graphene-wrapped zeolites⁶ have the subnanoscale channels of < 0.4 nm in width between graphene and their crystal faces, which induce a high selectivity.

References

- 1). R. Futamura, T. Iiyama, Y. Takasaki, Y. Gogotsi, M. J. Biggs, M. Salanne, J. Ségolini, P. Simon, K. Kaneko, (2017) Nature Mater. 16, 1163-1273.
- 2). K. Kaneko and F. Rodriguez-Reinoso Eds. (2019) Nanoporous Materials for Gas Storage, Chaps. 2 and 3, Springer.
- 3). S. Wang, F. Vallejos-Burgos, A. Furuse, J. P. Marco-Lozar, M. Nagae, H. Tanaka, H. Kanoh, J. Silvestre-Albero, T. Hayashi, K. Kaneko. Nature Energy, In revision
- 4). M. Zhang, W. Cai, Z. Wang, S. Fang, R. Zhang, H. Lu, A. E. Aliev, A. A. Zakhidov, C. Huynh, E. Gao, J. Oh, J. H. Moon, J. W. Park, S. J. Kim, R. H. Baughman, (2023) Nature Energy, 8, 203-213.
- 5). S. Utsumi, S. Kumar, S. Takahashi, R. Shimodome, T. Yamura, R. Okuda, R. Kobayashi, O. Takahashi, S. Miyazono, P. Ahuja, A. Furuse, D. Tomanek, K. Kaneko, Nature Nanotech. In second revision.
- 6). R. Kukobat, M. Sakai, H. Tanaka, F. Vallejos-Burgos, C. Lastoskie, M. Matsukata, Y. Sasaki, K. Yoshida, T. Hayashi, K. Kaneko, (2022) Sci. Adv. 8, eabl3521 (1-11).

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Session Classification: Wednesday

Track Classification: Keynote Speakers