Water Adsorption on Carbon Materials

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Adsorption isotherms of water on porous carbons, such as activated carbon, exhibit very large hysteresis loops. It is now believed that the origin of the hysteresis in water adsorption is different from that of adsorption of simple gases in mesoporous solids, where the difference in the curvature of the interface separating the adsorbed phase and the gas phase is the principal reason for the hysteresis. In this presentation, we present the differences of water adsorption isotherms on graphitized carbon black (flat surface), micropores, and mesopores, and discuss in details the mechanisms of water adsorption in these materials by analyzing the descending scanning curves (Fig. 1). For flat surfaces and misoporous solids, although hysteresis loops are observed the behavior of the hysteresis is different. For the flat surface, the loop extends over a very wide range of pressure and it is greater when descending is started at higher loadings; on the other hand, for the mesoporous carbon the hysteresis loop shows three distinct steps. For microporous carbon, the hysteresis is observed over a narrower range of reduced pressure than that for flat surfaces. By analyzing the desorption scanning curves from different loadings and the isosteric heat, we put forward the following mechanism for water adsorption: (1) water molecules adsorbing on functional groups located at the junctions between adjacent basal planes of graphene layers, (2) growth of water clusters around the functional groups, and (3) bridging of adjacent clusters to form condensate which eventually fill the confined space, and the extent of this pore filling depends on the size of the confined space [1-3].

We will also demonstrate the water adsorption isotherms on carbon materials which have a broad pore size distribution spanning from micropores to mesopores. One sample has a distinct micropore distribution from the mesopore distribution, while the other sample has continuous pore size distribution from micropore to mesopore [4, 5].

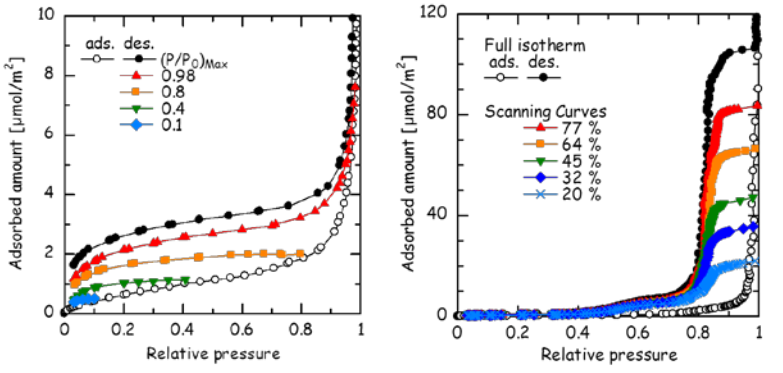

Fig. 1 Water adsorption isotherms and the scanning curves at 298 K on flat surface and mesoporous carbons

References:

[1] T. Horikawa, et al., *Carbon* **95**, 137-143, 2015.
[2] T. Horikawa, et al., *Aus J Chem* **68**, 1336-1341, 2015.
[3] T. Horikawa, et al., *J Colloid Interf Sci* **439**, 1-6, 2015.
[4] T. Horikawa, et al., *Carbon* **56**, 183-192, 2013.
[5] T. Horikawa, et al., *Carbon* **49**, 416-424, 2011.

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