STANDARD CONTACT POROSIMETER

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The porous structure properties of electrodes, separators, membranes, catalysts have a great influence on performances of batteries, fuel cells, etc. The widely known Method of Mercury Porosimetry (MMP) has several substantial disadvantages, for example, the necessity to apply high pressures of mercury (up to thousands of atmospheres), which can lead to a deformation or even destruction of the samples and to a distortion of the porosimetric curves (porograms). Other drawbacks MMP are: distortion of the results owing to amalgamation of most metals, different values of the mercury wetting angle for different materials, complexity of the equipment, and toxicity of mercury. We developed a new method - the Method of Standard Porosimetry (MSP) and Automated Standard Porosimeter (ASP). MSP and ASP have non of these disadvantages and give the possibility of measurements in a widest range of pore sizes (~ from 0.3 nm to $3x10^5$ nm) for any materials including soft or frail materials or amalgamating materials [1]. MSP is based on the laws of capillary equilibrium. If two (or more) porous bodies are in contact with one another and partially filled with a wetting liquid (hydrocarbons, water etc.) are in the state of capillary equilibrium then the values of the capillary pressure P of the liquid in these bodies are equal. The capillary pressure can be represented by the Laplace equation: $P = -2s \cos q/r$, where s - the surface tension of the liquid, q - the wetting angle, r - radius of pores. If for one of the porous bodies (the standard sample) the pore size distribution is known, then by determining an equilibrium dependence of liquid content for a test sample on liquid content for standard sample, the pore size distribution for the test sample can be calculated. The amount of liquid in the samples is determined by weighing.

The porous standards and test samples are preliminarily (under vacuum) filled with a liquid. The stack of porous samples is assembled in a special clamping device in which the samples are tightly pressed to each other. From this assembly a small portion of the liquid is evaporated by vacuum treatment or by a flow of dry inert gas.

The ASP includes a automatic manipulator for the assembling and disassembling of the stack of samples and for the transfer of the samples to the balance. Any porous and dispersed bodies can be investigated by MSP and ASP, for example, electrodes, membranes, separators, filters, catalysts, adsorbents, ceramics, metallic ceramics, textiles, pharmaceuticals , construction materials, polymers, geological strata, etc.

MSP/ASP allows for determination of a variety of information about porous and dispersed bodies: pore volume and specific surface distribution with respect to pore radii, specific surface area, information about a shape (corrugation) of pores, liquid distributions with respect to values of its free binding energy and capillary pressure with the testing material , sorption isotherms, differential characteristics of swelling, contact angle and its dependence on pore radii, characteristics of hydrophobic-hydrophilic properties, etc.

References

1. Y.M. Volfkovich, V.S. Bagotzky, V.E. Sosenkin, I.A. Blinov. In: Colloid and Surfaces. A: Physicochemical and Engineering Aspects. 187-188 (2001) 349-365.