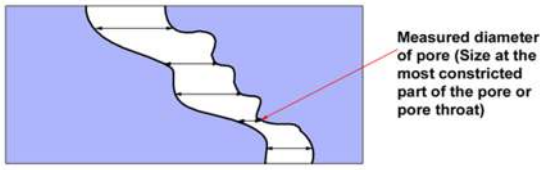
TESTING ON BATTERY

Lithium-ion Batteries are widely used in many types of consumer electronic devices as they are rechargeable and have high energy density as well as good electrochemical performance.
The LIB's use separator which is a permeable membrane placed between battery's anode and cathode. The separator keeps the two electrodes apart to prevent electrical short-circuits while allowing transport of ionic charge carrier to complete the circuit during passage of current in an electrochemical cell.
The market for lithium-ion battery (LIB) separator is expected to register a CAGR of 18.01%, during the forecast period (2019-2024) Source Morodor intelligence. Apart from consumer electronics, like laptops and cell phones, Electric Vehicle manufacturers are becoming one of the most significant customer bases of battery.

Pore Size of constricted pore as shown in fig1 is important parameter as the separator must have must have good insulation to prevent short circuit between positive and negative contacts or prevent short circuit caused by burrs, particles and dendrites



Some of the driving factors for the increasing demand of industrial batteries are:

- Growing Automotive Industry
- Increasing demand for power back-up
- Booming renewable energy-sector
- Recycling efficiency
- Lucrative replacement market

Porous Material Inc.

We at PMI Analytical Testing Services, are committed to helping you obtain the pore structure information you need. Because there are multiple techniques and instruments, it is critical at the onset to identify the appropriate method of measurement. We begin by discussing your application with you, understanding your needs, and providing you the solution that meets your needs. While PMI provides you with a detailed report, our application engineers are always available to discuss and help interpret your results.
PMI's Analytical Testing Services Division can accommodate a wide variety of samples, materials, and shapes. Sample size and consistency requirements vary with the test and material. For a large number of samples, special test conditions, or individual assistance, please contact PMI. We can analyze your samples and return your results to you (hard copy, on a disk, email, fax, or USPS) in as little as 1-2 business days.

Following are the types of Tests in our premises:

- Capillary Flow Porometery
- Liquid Liquid Porometery
- Water Intrusion Porosimeter

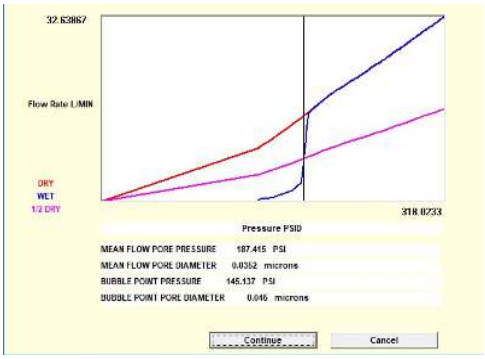
PMI testing services include measurement for:

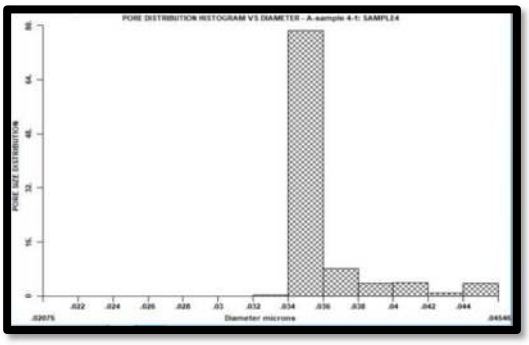
- Water entry pressure
- Pore size
- Pore size distribution
- Bubble point

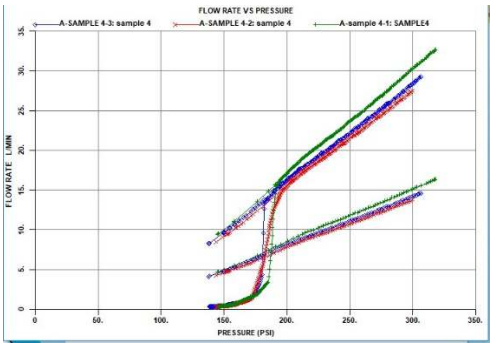
All these mentioned above can be tested using Capillary Flow Porometery, Liquid Liquid Porometery, Water Intrusion Porosimetery.

In this method, the pores of the sample are filled with a wetting liquid, the liquid is emptied by a pressurized gas permitting gas to flow through the empty pores. The differential pressure required to empty a pore of diameter. The largest pore is emptied at the lowest pressure and initiates gas flow. With increasing pressure smaller pores are emptied and gas flow increases. The differential pressures and gas flow rates through dry and wet samples are measured. In the dry sample, the flow rate increases with increase. In case of the wet sample, initially there is no flow because all the pores are filled with the liquid. At a certain pressure the gas empties the largest pore and gas flow starts through the wet sample. With further increase in pressure smaller pores are emptied and the flow rate increases until all the pores are empty and the flow rate through the wet sample is the same as that through the dry sample. The half-dry curve in this figure is computed from the dry curve to yield fifty-percent of flow through dry sample at the same pressure. The dry and wet curves yield the bubble point, the mean flow pore diameter, flow distribution and pore fraction distribution of through pores. The dry curve yields gas permeability and envelope (through pore) surface area. Liquid flow rate gives liquid permeability.

ATTACHED BELOW IS THE REPORT TESTED PMI MACHINES





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Sample Weight = 0.2640 g
Bulk Density = .4102 g/cc
Liquid = Water
Non-Mercury Contact Angle = 118 Degrees
Non-Mercury Surface Tension = 72 Dynes/cm

Cumulative pore volume in cc/g of sample
% total pore volume = % of total cumulative pore volume belonging to pores of
    diameter > D
Average pressure = square root of P(I)*P(I-1)
Pore size distribution function is equal to dV/dlog P
Surface area assumes cylindrical pores
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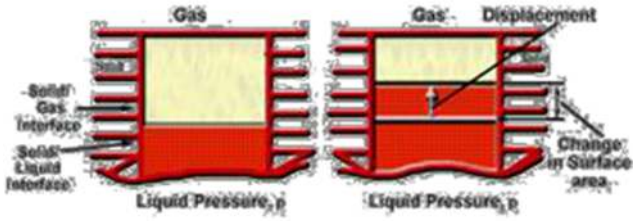
Pressure PSIA	Pore Diameter Microns	Cumulative Pore Vol. cc/g	%Porosity	% of total Pore Vol.	Average Pressure PSIA	dV ----- dlogP	Cumulative Surf. area m2/g
55.595	0.3526	0.0	0.0	0.0	55.595	0.017	0.0
63.995	0.3064	0.001	0.043	0.219	59.643	0.0	0.0126
78.895	0.2485	0.001	0.043	0.219	71.045	0.032	0.0126
94.065	0.2084	0.0035	0.147	0.743	86.141	0.0	0.0562
119.955	0.1634	0.0035	0.147	0.743	106.224	0.0	0.0562
143.955	0.1362	0.0035	0.147	0.743	131.408	0.0	0.0562
169.755	0.1155	0.0035	0.147	0.743	156.324	0.0	0.0562
213.705	0.0917	0.0035	0.147	0.743	190.467	0.0	0.0562
255.705	0.0766	0.0035	0.147	0.743	235.131	0.0	0.0562
302.355	0.0648	0.0035	0.147	0.743	279.68	0.168	0.0562
334.005	0.0587	0.0108	0.45	2.276	317.786	1.863	0.526



If you have any requirement then you can contact us on info@pmiapp.com , krishna@pmiapp.com or phone number +001 6072802357, or visit our website www.pmiapp.com

PMI Porous Materials Inc.

BE IN TOUCH WITH US

Phone: (607) 257-5544
Fax: (607) 257-5639
E-mail: info@pmiapp.com
Website: www.pmiapp.com
Address: 20 Dutch Mill Rd, Ithaca, NY 14850 USA