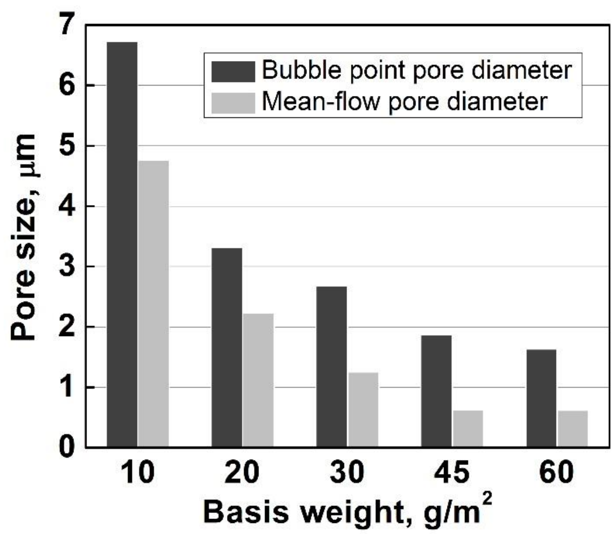
Effect of Basis Weight on Pore Sizes of Electrospun Fiber Mats

Nowoven fiber mats fabricated via electrospinning are composed of randomly aligned fibers and void spaces (pore structures) surrounding the fibers. When used as filter media for solid aerosol filtration applications, both the fiber properties and pore structures affect the filter performance. Fiber surfaces serve as the collector to capture the solid particles, and the pores provide the pathway for the flow through the media. Generally, open pores are considered as cylindrical tunnels with certain lengths and diameters. Capillary flow porometry is a widely used method to characterize the pore properties as well as quantify the pore characteristics, including bubble point pore diameter and mean-flow pore diameter. Bubble point pore diameter is defined as the diameter of the largest pore in a porous medium, and mean-flow pore diameter is defined as a mean diameter at which 50% of the total flow is accumulated. These two pore diameters were found to be dependent on the basis weight of the electrospun fiber mats.

Submicron acrylonitrile-butadiene copolymer fibers were electrospun to prepare flat fiber mats of different basis weights. Bubble point and mean-flow pore diameters were measured using a capillary flow porometer, as shown in the plot below. During electrospinning process, the collected fibers initially packed to form a thin fiber mat layer, fill the void spaces, and narrow the pores. As electrospinning proceeded, when the packing of the fibers reached certain limit, the fiber collection no longer reduced the pore sizes, while started to grow the fiber mat thickness. Therefore, it was hypothesized that the pore sizes would decrease firstly and then become constant afterwards.



In the plot, both the bubble point and mean-flow pore diameters reduce at lower basis weights. Starting at about 45g/m^2, the diameters begin to level off, in which case the minimum plateau is achieved. Hence the hypothesis is proven by the experimental results. Moreover, the mean-flow pore diameters are roughly half of the bubble point pore diameters.

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