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Hierarchical Fiber Structures Made by Electrospinning Polymers

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A filter for water purification that is very thin, with small interstices and high surface area per unit mass, can be made with nanofibers. The mechanical strength of a very thin sheet of nanofibers is not great enough to withstand the pressure drop of the fluid flowing through. If the sheet of nanofibers is made thicker, the strength will increase, but the flow will be reduced to an impractical level. An optimized filter can be made with nanometer scale structures supported on micron scale structures, which are in turn supported on millimeter scale structures. This leads to a durable hierarchical structure to optimize the filtration efficiency with a minimum amount of material. Buckling coils,¹ electrical bending coils² and pendulum coils³ spanning dimensions from a few microns to a few centimeters can be collected from a single jet by controlling the position and motion of a collector. Attractive routes to the design and construction of hierarchical structures for filtration are based on nanofibers supported on small coils that are in turn supported on larger coils, which are supported on even larger overlapping coils. “Such top-down” hierarchical structures are easy to make by electrospinning. In one example, a thin hierarchical structure was made, with a high surface area and small interstices, having an open area of over 50%, with the thinnest fibers supported at least every 15 microns.

¹Tao Han, Darrell H Reneker, Alexander L. Yarin, *Polymer*, Volume 48, issue 20 (September 21, 2007), p. 6064-6076.

²Darrell H. Reneker and Alexander L. Yarin, *Polymer*, Volume 49, Issue 10 (2008) Pages 2387-2425, DOI:10.1016/j.polymer.2008.02.002. Feature Article.

³T. Han, D.H. Reneker, A.L. Yarin, *Polymer*, Volume 49, (2008) Pages 2160-2169, doi:10.1016/j.polymer.2008.01.0487878.