herein include fabrics, sheets, wires, structural supports or membranes for fluid purification. Electrical, mechanical and thermal properties associated with the carbon nanotube further allow the nanostructured materials to be used for higher performance mechanical actuators, heat sinks, thermal conductors or electrodes.

Given the acute need for materials with these improved performance characteristics in many applications there is a need for methods that produce these materials in large quantities. Accordingly, the present disclosure relates to a method of making a carbon nanotube nanostructured material in large quantities, such that the resulting product can be sized for a variety of applications from filter media to fabrics for electrical or mechanical uses.

SUMMARY OF INVENTION

The following disclosure describes large-scale production methods for making large quantities of macro-scale, nanostructured material. As described below, the method can be a continuous~~,~~ or semi-continuous~~, or batch~~ process that is based on the differential pressure filtration of a carrier fluid containing carbon nanotubes, with or without other components, including fibers, particles, and the like.

In one embodiment, the present disclosure relates to a method of making a nanostructured material comprising carbon nanotubes~~.~~ said~~The~~ method ~~typically~~ comprisinges suspending carbon nanotubes in a carrier fluid to form a mixture, inducing the mixture to flow through a moving substrate that is *permeable to the carrier fluid by differential pressure filtration*, ~~and~~ depositing the carbon nanotubes (and optional components such as glass fibers), from the mixture onto the moving substrate and applying a vacuum to the side of the substrate opposite of the deposition side to remove said carrier fluid, to form a

nanostructured material whose components have an arrangement that has at least one characteristic length scale that is 100 nanometers or less. The large-scale nanostructured material is one having at least one dimension greater than 1 cm.

The present disclosure ~~also~~ relates to a continuous or semi-continuous method for making a nanostructured material comprising carbon nanotubes. In an~~this~~ embodiment, the carbon nanotubes are deposited from the mixture onto a moving substrate to form a nanostructured material having a length greater than 1 meter. This embodiment enables very large nanostructured material to be formed, such as a material having at least one dimension greater than 1 meter, for example a length of hundreds or thousands of meters, and up to ten thousand meters.

~~There is also disclosed a batch method for making a nanostructured material. Unlike the continuous or semi-continuous method, the batch method comprises depositing the carbon nanotubes from a mixture onto a stationary substrate that is permeable to the carrier fluid. While a batch method does not typically permit materials to be formed of the same size, such as length, as the continuous or semi-continuous method, it is able to produce a macro-scale nanostructured material, such as one having at least one dimension greater than 10 cm.~~

The method described herein may be used to make a wide variety of novel products, such as a macro-scale, nanostructured material for filtering fluids. This method may be used to directly deposit a seamless nanostructured material onto a substrate that will become an integral part of the final product. In one embodiment, this method can be used to deposit macro-scale nanostructured material onto a filter media, such as a porous carbon block.

Aside from the subject matter discussed above, the present disclosure includes a number of other exemplary features such as those explained hereinafter. It is to be understood that both the foregoing description and the following description are exemplary only.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying figures are incorporated in, and constitute a part of this specification.

Fig. 1 is a schematic of a system for the continuous production of a nanostructured material according to the present disclosure.

Fig. 2 is a schematic of a continuous roto-former deposition system for the fabrication of a nanostructured material according to the present disclosure.

Fig. 3 is a schematic of a system for the direct deposition of nanostructured material on a rigid substrate to form a seamless product according to one embodiment of the present disclosure.

Fig. 4 is a schematic of a continuous wire type system for making a nanostructured material according to one embodiment of the present disclosure.