

EXPANDED COMPOSITE FILTER MEDIA INCLUDING NANOFIBER MATRIX AND METHOD

FIELD OF THE INVENTION

[0001] This invention generally relates to a filter media, and in particular to a composite filter media comprising an expanded substrate and fine fibers carried thereon, and method of making the same.

BACKGROUND OF THE INVENTION

[0002] Fluid streams such as liquid flows and gaseous flows (e.g. air flows) often carry particulates that are often undesirable contaminants entrained in the fluid stream. Filters are commonly employed to remove some or all of the particulates from the fluid stream.

[0003] Filter media including fine fibers formed using an electrostatic spinning process is also known. Such prior art includes Filter Material Construction and Method, U.S. Patent No. 5,672,399; Cellulosic/Polyamide Composite, U.S. Patent Publication No. 2007/0163217; Filtration Medias, Fine Fibers Under 100 Nanometers, And Methods, U.S. Provisional Patent Application No. 60/989,218; Integrated Nanofiber Filter Media, U.S. Provision Patent Application No. 61/047,459; Filter Media Having Bi-Component Nanofiber Layer, U.S. Provisional Patent No. 61,047,455, the entire disclosures of which are incorporated herein by reference thereto. As shown in these references nanofibers are commonly laid upon a finished preformed filtration media substrate.

[0004] Embodiments of the invention seek to provides improvement in filter media including fine fibers. These and other advantages of the invention, as well as additional inventive features, will be apparent from the description of the invention provided herein.

BRIEF SUMMARY OF THE INVENTION

[0005] Fine fibers, such as and most preferably electrospun nanofibers according to certain embodiments, laid upon a substrate media can be reoriented after laying by modifying the substrate media, such as by modifying the thickness of that substrate media after the fine fibers are deposited. For example, an at least partially compacted substrate media (such as calendared media) can be expanded, in which larger fibers carry with them the smaller fibers thus also expanding the fine fiber layer. As a consequence, several advantages can flow from this, including greater volumetric coverage of nanofibers (more volumetric coverage for a same basis weight application – as the expansion can open up and expand the nanofibers into a 3D matrix); reduced pressure drop due to expansion; and/or slower pressure drop increase as it loads. Additionally, the undulating 3 dimensional characteristics of the nanofiber or other such fine fiber layer may greatly increase dust holding capacity as it is believed to effectively create an undulating surface with a much greater volumetric holding area as opposed to merely flat, as in the case of prior systems – thus the effective volumetric area of the nanofiber layer can be increased.

[0006] In one embodiment, the substrate is a bi-component scrim including a high melt component and a low melt component. The fine fibers are electrospun polymer nanofibers. The high melt component and the electrospun polymer nanofibers have a higher melting temperature than the low melt component. The bi-component scrim has an unexpanded state and an expanded state, wherein the expanded bi-component scrim has a thickness greater than the unexpanded state. For example, the scrim in the unexpanded state may be preformed and calendared and thereby or otherwise at least partially compressed in which the fibers held in position in a biased state by being bonded and thereby held to one another (large fiber to fiber bonds holding these large fibers in place). In one embodiment, the unexpanded bi-component scrim carrying the fine fibers is expanded by heating, wherein the low melt component melts or softens and bonds with the fine fibers. During this heating, the larger fibers of the substrate are also freed from at least partially compressed state and allowed to slide about and move back toward a more natural state – such as at least partially toward uncompressed and expanded state (e.g. toward the uncompressed that occurred prior to the formation of the scrim in the first place). During heating, the larger fibers of the bi-component scrim may be relaxed and reoriented, carrying the much smaller fine

fibers therewith, wherein the fine fibers extend with expanding bi-component scrim. The resulting composite filter media ~~may have~~ has an undulating surface and an expanded thickness causing the fine fibers to not merely have a planar characteristic as is the case with conventional nanofiber laying techniques, but a 3 dimensional matrix. The expanded filter media ~~may have~~ has improved dust holding capacity, a slower pressure drop increase as dust loads, and/or lower initial pressure drop.

[0007] In one aspect, the invention provides a method of making a filter media. The method includes steps of depositing fine fibers on a surface of a substrate having a first thickness, the fine fibers having an average diameter of less than 1 micron, and expanding the substrate to a second thickness greater than the first thickness carrying the fine fibers therewith.

[0008] In another aspect, the invention provides a filter media comprising a substrate of first fibers having an average fiber diameter of greater than 1 micron carrying fine fibers having an average fiber diameter of less than 1 micron. The substrate has an undulating surface, wherein the fine fibers are integrated into 3-dimensional matrix with the first fibers of the undulating surface.

[0009] Other ~~aspects~~, objectives and advantages of the invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] The accompanying drawings incorporated in and forming a part of the specification illustrate several aspects of the present invention and, together with the description, serve to explain the principles of the invention. In the drawings:

[0011] FIG. 1 is a schematic cross-sectional view of an expanded composite filter media having an undulating surface comprising fine fibers carried by a substrate media according to an embodiment of the present invention;