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POROUS NYLON FIBER RODS

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ABSTRACT OF THE DISCLOSURE

Porous nylon fiber rods adaptable for use as a wick in fiber point pens include a plurality of continuous lengths of substantially parallel nylon fibers which are autogenously bonded together along selected contiguous fiber surfaces. The fiber rod is twisted helically about its central axis and has a density of from about 1.00 to about 0.60 gms./cm.^{3} which provides the rod with a series of interconnecting liquid conducting passageways.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to the production of porous nylon fiber rods and, more specifically, to porous nylon fiber rods capable of wicking fluids at a desired rate of flow and of being machined to a fine point with the point being able to withstand prolonged use without becoming dull or shredding.

(2) Description of the prior art

The use of fibrous materials as pen points is quite old in the art; however, the prior art pen points which are made from fibrous material and are capable of wicking have unusually short lives and cannot withstand continued use when compared with a metal tipped pen point or the like. Also, the wickability of the prior art fibrous pen points cannot easily be predetermined due to the variations in the length of fibers and of the binders used to bind the fibers together. As disclosed in U.S. Pat. 3,400,998, the fibers are held together by means of an adhesive binder which limits the control over rod porosity causing variations of the same.

SUMMARY OF THE INVENTION

The porous nylon fiber rods of this invention include a plurality of lengths of nylon fibers which are helically twisted about the rod central axis and which are bonded together along portions of their contiguous surfaces. The density of fibrous rods ranges from about 1.0 to about 0.60 gm./cm.^{3}, the porosity depending upon the degree of twist and the tension to which the rods are subjected during the bonding process. The denier of the individual nylon fibers comprising the rods may vary from about 1 to about 100; however, the general denier range is from 3 to about 15 with 6 having been found to be satisfactory for most fiber rod purposes. Where 6 denier fibers are employed in the rods, the average number of fibers required to make a rod ranging from 65 to 85 mils in diameter is generally from about 2200 to about 2800. Rod diameters from 65 to 85 mils are generally preferred for general office work although greater or smaller diameters may be used depending upon the end use of the particular fiber rod. For example, when marking heavy corrugated boxes, the rod diameter may be as high as 120 mils but when being used for making accounting entries, the diameter of the rods may be as small as 50 mils.

The nylon filament fibers comprising the fiber rod are bonded together autogenously, that is, no outside agent remains in or around the nylon fibers after the completion of the bonding process. Bonding occurs by contacting the fibers with a chemically active gaseous substance which upon being absorbed by the nylon filaments causes a disruption in the interchain hydrogen bonding between adjacent amide groups within the nylon filaments. The covalent bonds within the polyamide chains are not broken or substantially altered. Upon removal of the gas from the polyamide filaments, the interchain hydrogen bonding between contiguous amide groups of adjacent nylon fibers are reformed as well as between the molecular chains comprising the body of the fibers. The gas may be mixed with other gases or may be dissolved in a nonionizing organic liquid solvent which is chemically inert to the polyamide fibers and which serves as a carrier for the gas. The activating gases which may be combined with other inert gases or which may be dissolved in a suitable liquid solvent include hydrogen chloride, hydrogen bromide, boron trifluoride, boron trichloride, sulfur trioxide, nitrogen trioxide and a combination of sulfur dioxide and chlorine. These and other related gases do not significantly degrade the fiber but, while in contact with the fiber, disrupt the interchain hydrogen bonds between the adjacent amide groups as mentioned above. The nonionizing liquid solvents in which the activating gases may be dissolved include acetone, ether, chloroform, carbon tetrachloride, benzene, pentane, heptane, trichlorofluoromethane, and other like organic liquids in which the gas remains substantially nonionized and which are chemically inert to the polyamide fibers. The bonding liquid may be prepared by bubbling the gas into the organic liquid solvent carrier for a selected interval of time.

Therefore, an object of this invention is to provide a porous nylon fiber rod which is capable of wicking ink and which is suitable for use as fiber points in felt pens or the like.

Another object of this invention is to provide a fiber point pen with a wicking rod which is capable of enduring long use.

Another object of this invention is to provide a porous nylon rod which has a porosity adapting it for use as a wicking element for fiber point pens.

More specific objects and advantages will be apparent to those skilled in the art from the following detailed description which illustrates and discloses but is not intended to limit the scope of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The porous nylon fiber rods of this invention are comprised of a plurality of small nylon fibers which are substantially parallel to each other and which are autogenously bonded together along selected contiguous surfaces. The nylon filaments are autogenously bonded together and are twisted in such a manner as to form conducting passageways to provide the desired wickability. The density of the fiber rods which is a measure of porosity ranges from about 1.00 to about 0.60 gms./cm.^{3} with the density being determined by the number of twists per inch and the tension to which the rods are subjected while undergoing the bonding process. The density of the fiber rods determines the wickability of the same and by increasing or decreasing the density, the rate at which the ink in the pen reservoir flows through the rod by means of interconnecting liquid conducting passageways to a writing surface is proportionately affected. At densities below 0.60 gm./cm.^{3}, the rods are soft and transfer the ink freely to the writing surface and become frayed or bushy after little use. At a density above 1.00 gm./cm.^{3}, the fiber rod is hard and sustained writing is accomplished only with difficulty for the rod is incapable of wicking the ink at sufficient flow quantities to supply the pen tip. By way of comparison, nylon has a density depending on

the particular mode of polymerization of from about 1.14 to about 1.20 gm./cm.^{3}.

Fiber rods used for pen tips have a diameter generally ranging from 55 to 85 mils. Fiber rods of the mentioned diameter are generally comprised of from 2200 to 2800 round 6 denier filament fibers. The fibers are generally cut into 20-inch lengths and secured at each end and twisted approximately one half turns per inch. An alternative method for forming the rod includes the cutting of the fibers into 20-inch lengths, forming yarns of approximately 140 fibers per yarn, twisting each yarn one half turn per inch and then combining from 16 to 20 yarns and twisting the total one half turn per inch. It has been found that by forming yarns of 140 fibers, the fialments are easier to handle and do not pendent fibers dangling from the edges of the fiber rod.

The bonding liquid is prepared by bubbling gaseous hydrogen chloride through chloroform until the concentration is about 0.15 N CHl. The fibers while in a substantially flared state are submerged in the bonding liquid for a period of about 10 seconds and upon removal of the fibers, the mass is slowly twisted to provide a total twist of 0.4 twist per inch. After approximately 80 seconds, the twisted filaments are loaded with a 50-gram load and are allowed to stand about 5 minutes before washing in boiling water at 100° C. for 10 minutes. Depending upon th tension, the time the fibers remain in the bonding liquid, the amount of twist imparted in the fibers and the length of time between twisting and washing, the density ranges from about 1.00 to about 0.60 gm./cm.^{3}.

EXAMPLE I

A bonding liquid of hydrogen chloride and chloroform was prepared by bubbling hydrogen chloride gas through the chloroform until the concentration was 0.15 N CHl. A strand including 18 lengths of yarn which were 20 inches long and which were comprised of 140 filaments each at 0.5 twist per inch were submerged in 400 ml. of the bonding liquid for a period of 20 seconds. Upon removal of the fibers from the bonding liquid, the total strand was twisted to provide 0.4 twist per inch during a 90-second interval. After twisting, the strand was placed under 50 grams of tension and was allowed to stand for five minutes whereupon the strand was submerged into boiling water at 100° C. After remaining in boiling water for 10 minutes at which time the hydrogen chloride and the choloroform are removed from the strand, the strand was dried and had the appearance of a fiber rod with a density of 0.80 gm./cm.^{3}. The diameter of the fiber rod was 75 mils and had the characteristics of being tough while retaining the desired wickability.

EXAMPLE II

The procedure as set forth in Example I was repeated with the exception that 16 yarns of filaments were submerged in 500 mls. of bonding liquid. The resulting density was 0.82 gm./cm.^{3} which would indicate a slight increase in density as set forth in Example I since the number of yarns comprising the strand was reduced by two.

EXAMPLE III

The procedure as set forth in Example I was repeated with the exception that the strand was submerged in 300 mls. of bonding liquid and was allowed to remain therein 10 seconds. The resulting density of the fiber rod was 4.79 gm./cm.^{3}.

EXAMPLE IV

The procedure as set forth in Example I was repeated with the exception that 16 strands of fibers were submerged in 300 mls. of bonding liquid for a period of 60 seconds. The strand was twisted to 0.2 twist per inch and after twisting was placed under 1000 grams of tension. The resulting density was 0.92 gm./cm.^{3} which was due mainly to the excess tension placed on the strand.

EXAMPLE V

The procedure as set forth Example I was repeated with the exception that the yarns comprising the strand were placed into 300 mls. of bonding liquid for 10 seconds and the resulting strand was placed under 100 grams of tension. The resulting density was 0.81 gm./cm.^{3}. It can be seen that although the tension under which the strand was placed was twice the tension of Example I, the amount of time the strand remained in the bonding liquid was reduced by half resulting in fiber rods having substantially equal densities.

We claim:

1. A porous nylon fiber rod comprising a plurality of lengths of nylon fibers being autogenously bonded together along selected contiguous fiber surfaces, said fibers being twisted about a rod axis and said fiber rod having interconnecting liquid conducting passageways and having a density of from about 1.0 to about 0.6 gm./cm.^{3}.

2. The fiber rod of claim **1** wherein said rod includes a plurality of twisted yarns, said yarns being comprised of a plurality of lengths of nylon fibers.

3. The fiber rod of claim **2** wherein the diameter of said rod is from about 65 to about 85 mils.

4. The fiber rod of claim **3** wherein said nylon fibers are from about 3 to about 15 denier.

5. The fiber rod of claim **4** wherein said porosity is about 0.80 gm./cm.^{3}.

6. The fiber rod of claim **1** wherein said lengths of nylon fibers are twisted to about 0.4 turn per inch.

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