

DESCRIPTION

CLEANING TOOL

FIELD OF THE INVENTION

The present invention relates to a cleaning tool suited for cleaning of minute recessed portions.

BACKGROUND OF THE INVENTION

Staining of the parts of electronic apparatuses such as semiconductor components and magnetic recording media causes significant deterioration in the performance of the parts. Accordingly, it has been practiced to keep the surfaces of parts clean by wiping stain off the surface with hand using wiping cloth made of fine fibers.

Such an operation as shown in Fig. 5 is also in practice wherein recessed surfaces are cleaned with a pointed stick wrapped with a wiping tape 1a, that is a narrow strip cut from the wiping cloth 1 described above. Alternatively, it has been proposed to wind the wiping tape 1a described above in a roll and press the wiping tape 1a against an object (hard disk, etc.) to be cleaned while unwinding the wiping tape 1a (Japanese Unexamined Patent Publication No. 10-106229, etc.).

However, as the electronic parts become further smaller with higher precision, recently it has been required to clean the inside of cylindrical objects having diameters of 1 to 2 mm or

bumps and recesses about 1 mm across, such as the inside of bearing for hard disk motor and terminals of liquid crystal display panel. The conventional wiping tape 1a is not capable of meeting these requirements.

In particular, thermal cutting has been used to cut the wiping tape 1a. Since thermal cutting cuts off fibers with heat, ends of the fibers at both cut edges 2 of the wiping tape 1a are, once melted and then hardened, turned into hard lumps of resin as shown in Fig. 6 that deprive the fabric of the characteristic softness. When the wiping tape 1a is cut to a width of 10 mm or less, for example, proportion of the hardened edge portions 2 to the entire fabric becomes high enough to damage the portion to be cleaned or cause a problem of the lumps of resin coming off thereby generating dust. Also there has been such a problem that the hardened portions have higher rigidity and therefore are difficult to comply with small ups and downs on the surface, resulting in insufficient cleaning performance.

The present invention has been made to solve these problems, and has an object of providing a high performance cleaning tool that is capable of cleaning any tiny surface irregularities and the inside of tiny recesses or gaps of the object to be cleaned.

DISCLOSURE OF THE INVENTION

An embodiment of the present invention may provide a cleaning tool comprising a cord-like

structure formed from yarn, that includes at least in part thereof fine fibers having fineness of single fiber of 1.1 decitex or lower, being entwined so that ends of fibers are not exposed to the outside of the fabric with total surface area being from 150000 to 2500000 m² per 1 m³ and apparent density being from 100000 to 700000 g/m³.

An aspect of the present invention provides a cleaning tool comprising a cord-like structure formed from yarn, that includes at least in part thereof fine fibers having fineness of single fiber of 1.1 decitex or lower, being knitted or braided into a cord shape so that ends of fibers are not exposed to the outside of the fabric, the cord-like structure having total surface area being from 150000 to 2500000 m² per 1 m³ and apparent density being from 100000 to 700000 g/m³.

One embodiment of the present invention is a particular type of the cleaning tool wherein the cord-like structure can be a knitted fabric that is formed by either circular knitting, tricot knitting or flat knitting.

Another embodiment of the present invention is, among the cleaning tools described above, a particular type of the cleaning tool wherein the cord-like structure can have width of 2 mm or less and thickness of 1 mm or less, and a further embodiment of the present invention is a particular type of the cleaning tool wherein stitches appearing on the surface of the cord-like structure may be arranged in a direction inclined by an angle of 20° to 90° from the longitudinal direction of the cord-like structure.

3a

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 shows an overview of an example of the present invention.

Fig. 2 is a partially enlarged view of the example described

above.

Fig. 3(a) through (i) show various shapes of fibers of cleaning tapes used in the example described above.

Fig. 4(a) and (b) show modes of using the example described above.

Fig. 5 shows an example of cleaning tool of the prior art.

Fig. 6 is a diagram explaining the problems in the prior art.

Fig. 7 is a diagram explaining Example 3 of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

Now preferred embodiments of the present invention will be described below.

Fig. 1 shows a cleaning tool according to an embodiment of the present invention. This cleaning tool comprises a cord-like structure 10 that is formed from yarn which includes, at least in part thereof, particular fine fibers entwined to form a cord so that ends of fibers are not exposed to the outside of the fabric.

The cord-like structure 10 may be, in addition to a knitted fabric that is formed by either circular knitting, tricot knitting or flat knitting, a braided cord formed by entwining fibers, not by knitting. The cord-like structure also includes plain yarn itself that is not braided or knitted, such as folded yarn that is twisted and covered yarn. It can be said, however, that the

cord-like structure 10 is preferably constituted so that stitches appearing on the surface of the cord-like structure are arranged in a direction inclined by a certain angle from the longitudinal direction of the cord-like structure 10, which produces higher cleaning effect when wiping by running the cleaning tool in the longitudinal direction of the cord-like structure. Specifically, the cord-like structure is preferably knitted or braided so that the angle θ (refer to Fig. 2 showing partial enlargement of Fig. 1) is from 20° to 90° such as, for example, a plain stitch structure produced with a circular knitting machine or a tricot fabric produced with a tricot machine. In case plain yarn is used such as folded yarn or covered yarn, it is preferable to give a constant angle, similar to θ described above, from 20° to 90° by twisting or covering. In the case of an ordinary braided cord, in contrast, the angle θ is almost 0° (all stitches are substantially aligned in the longitudinal direction) and therefore cleaning effect tends to be a little lower when wiping by running the cleaning tool in the longitudinal direction.

The yarn that constitutes the cord-like structure 10 must use, at least in part thereof, fine fibers in order to ensure desired cleaning effect. Fineness of the fine fiber is determined in accordance to the object surface to be cleaned. In order to clean minute portions of objects such as computer keyboard, telephone, cell phone and jewelry, the cord-like structure may be formed from yarn made of the fine fiber of which fineness of

single fiber is 1.1 decitex or less. When more precision is required, such as cleaning the inside of a bearing for hard disk motor or terminals of liquid crystal display panel, ultra-fine fibers of which fineness of single fiber is 0.6 decitex or less, particularly around 0.1 decitex, are preferably used. There is no limitation to the material of the fibers, as long as the material makes synthetic filament such as polyamide, polyester, polypropylene and polyethylene.

Such a fine fiber can be made by processing a conjugate fiber that comprises two or more components bonded together while forming a plurality of segments in single fiber, so as to turn the conjugate fiber into split fibrils. The split fibril can be formed by removing one of the components by dissolving or decomposition, swelling the component by means of a swelling agent, contracting the component by means of a shrinking agent, or deforming and shrinking the component by heating. Physical splitting of the plurality of components by friction or striking may also be employed. It is particularly preferable to dissolve and remove one of the components by using sodium hydroxide solution thereby to split the fibers, which enables it to render the resultant cord-like structure 10 soft touch without hard contact. The splitting process is usually carried out after forming the yarn, that includes the conjugate fibers at least in part thereof, into cord shape.

Fig. 3(a) through (i) show examples of the cross section

of conjugate fiber suitable for making split fibrils. Splitting the fibers shown in Fig. 3(a) and Fig. 3(f), for example, produces fine fibers of which two components both have flat configuration. The fiber shown in Fig. 3(b) has the two components arranged alternately in the form of a number of fan-shaped segments. The fiber shown in Fig. 3(c) combines one component formed in radial shape and the other component formed in fan shape. Fig. 3(d) shows an example where one component formed in radial shape is integrated in the other component. Fig. 3(e) shows an example where one component is dispersed irregularly like islands in the other component. Fig. 3(g) shows an example where one component is integrated as multiple cores in the other component. Fig. 3(h) shows an example where two components are arranged alternately in a circle, with the central portion being hollow. Fig. 3(i) shows an example where two components are arranged alternately in one direction. The fine fiber can be formed in any other compound constitution as well as those described above, as long as each component is divided in segments. Among these, the fine fiber comprising the conjugate fibers shown in Fig. 3(b) and Fig. 3(c) have sharp edges that improve the cleaning effect, and are therefore preferable.

The cord-like structure 10 used for the cleaning tool of the present invention has a certain level of cleaning effect as long as the fine fibers are used in at least part thereof. In case a knitted fabric is used for the cord-like structure 10, for

example, either the whole structure may be formed from a yarn made of the fine fiber, or a yarn made of the fine fiber and an ordinary yarn may be mixed and knitted in predetermined proportions. Sufficient cleaning effect can be achieved when the proportion of the fine fiber is 30% or higher.

Size of the cord-like structure 10 is, when formed in a band shape, preferably 2 mm or less in width and 1 mm or less in thickness. When the cord-like structure 10 is a round cord, it preferably has a diameter of 2 mm or less. Making the cord-like structure 10 with such a small size makes it possible to effectively clean the inside of small cylinders and surfaces having minute irregularities. In case the cord-like structure 10 is made in tubular shape having annular cross section by circular knitting or the like, it is preferable that width and thickness of this cord that is placed on a horizontal surface and is flattened are in the ranges described above.

For the cord-like structure 10 to have good cleaning performance, it must be made with such knitting conditions (types of yarn and needle, number of course, etc.) that total surface area is in a range from 150000 to 2500000 m^2 per 1 m^3 . When the total surface area is below 150000 m^2 per unit volume, sufficient cleaning performance cannot be achieved. When the total surface area exceeds 2500000 m^2 per unit volume, manufacturing cost becomes higher while the cleaning performance does not improve.

In order for the cord-like structure 10 to have compliance

and good contact with the surface of object to be cleaned, it must be made with such knitting conditions that the apparent density is from 100000 to 700000 g/m³. When the apparent density is below 100000 g/m³, sufficient cleaning performance cannot be achieved due to the presence of too much void. When the apparent density exceeds 700000 g/m³, sufficient cleaning performance cannot be achieved because the fibers are crowded too close to each other.

The cord-like structure 10 thus obtained is cut to proper length and used in the cleaning tool. To clean the inside of cylindrical bodies (inner diameter 1 to 2 mm) such as the bearing for hard disk motor, the inside can be cleaned by inserting and sliding the cord-like structure 10 through the hollow space of the cylindrical body 20 as indicated by imaginary line in Fig. 1.

The cord-like structure 10 may also be stretched between ends of substantially C-shaped portion of a fixture 11 as shown in Fig. 4(a), for cleaning of narrow gaps.

Moreover, as shown in Fig. 4(b), the cord-like structure 10 may be wound around a cylindrical roll 12 with every turn placed close to the adjacent ones without gap, to make a cleaning roll. The cleaning roll 12 is rolled over the surface to be cleaned such as hard disk. This cleaning operation may be carried out while supplying an alkali solution, alcohol or a polishing liquid that includes a polishing agent onto the surface to be cleaned, to make the cleaned surface smoother.

The cleaning tool of the present invention does not damage the objects to be cleaned nor generate dust of hardened resin coming off the ends of thermally cut fibers, since the cleaning tool comprises the cord-like structure 10 formed from yarn that includes specific fine fiber in at least a part thereof, and is formed into the shape of a cord so that the ends of the fibers are not exposed to the surface of the cord, as described above. Also because the cord has a special structure having total surface area per unit volume and apparent density being set within predetermined ranges, it is made possible to easily and effectively clean surfaces that have minute irregularities, small gaps and the inside of small cylindrical objects such as miniature bearing housing.

When the cleaning tool of the present invention is used in a semiconductor manufacturing process or the like that requires high precision, it is preferable that dust generation from the cord-like structure 10 that constitutes the cleaning tool is controlled so that particulates measuring 0.3 to 5.0 μm across are substantially unobservable. The expression of "substantially unobservable" means that, upon measuring dust generation from a sample three times or more according to tumbling method in compliance to IES-RP-CC-003-87-T standard, average number of particulates observed measuring 0.3 to 5.0 μm across is 10 or less.

EXAMPLES

Examples of the present invention will be described below in conjunction with Comparative Examples.

Example 1

Twist of 110 T/M in direction S was applied to three filaments of splittable conjugate fiber having cross section shown in Fig. 3(c) (radially disposed component of 6-nylon and 8-segment fan-shaped component of polyester combined with fineness of 56 decitex/25 filaments), to make plied yarn of 168 decitex/75 filaments. Three strings of the plied yarn were put together and knitted into a plain stitch structure using a circular knitting machine (shuttle diameter about 5 mm, three needles), with the resultant cord-like knitting being wound into the form of hank. Then denier reduction was applied under the conditions described below with a yarn dyeing machine, followed by washing in warm water of 60°C, dehydration and drying.

[Conditions of denier reduction]

Processing liquid:	Aqueous NaOH solution
Concentration:	29 g/liter
Temperature:	98°C
Duration:	40 minutes

Volume reduction ratio resulting from the denier reduction process was 12%, and the three conjugate fibers that constitute the knitting fabric were each divided into eight polyester fibers and one 6-nylon fiber. Fineness of single polyester fiber was

about 0.16 decitex.

The cord-like knitting described above was cut with heat to a length of 1 m, washed in ion-exchanged water and then dried. The cord-like knitting thus obtained had a cylindrical shape of about 1 mm in diameter, without any ends of cut fibers exposed to the outside that serves as the cleaning surface, with inclined line of stitches (loop) being arranged regularly.

Example 2

A cord-like knitting was obtained similarly to Example 1 except for using six needles in the circular knitting machine of Example 1. In this cord-like knitting that had a form of tape about 2.8 mm in width and about 0.9 mm in thickness, too, the ends of cut fibers were not exposed to the outside that served as the cleaning surface and inclined lines of stitches (loop) were arranged regularly.

Example 3

A cord-like knitting was obtained similarly to Example 1 except for using three strings of the plied yarn of Example 1 put together and knitted into a grey fabric with a flat knitting machine (18G, knitting width 30 mm). In this cord-like knitting that had a form of tape about 5 mm in width and about 2.5 mm in thickness (curled in the direction of width as shown in Fig. 7), too, the ends of cut fibers were not exposed to the outside that serves as the cleaning surface and inclined line of stitches (loop) were arranged regularly.

Example 4

Primary twist of 900 T/M in direction S was applied to the splittable conjugate fiber (110 decitex/50 filaments) similar to that of Example 1 to make plied yarn. Two strings of this yarn were plied together by applying twist of 600 T/M in direction Z, opposite to that of the primary twist, thereby making folded yarn. The folded yarn was subjected to the denier reduction and the following processes similarly to Example 1 thereby to obtain folded yarn constituted from fine fibers. In this folded yarn thus obtained that was formed in a form of tape about 0.36 mm in width and about 0.18 mm in thickness, too, the ends of cut fibers were not exposed to the outside that served as the cleaning surface and inclined line of stitches were arranged regularly.

Example 5

Splittable conjugate fibers (110 decitex/50 filaments) similar to that of Example 1 were used as core thread and sheath thread so as to make covered yarn with 1000 turns/m of covering. The covered yarn was subjected to the denier reduction and the following processes similarly to Example 1 thereby to obtain covered yarn constituted from fine fibers. In this covered yarn thus obtained having cylindrical shape with diameter of about 0.53 mm, too, the ends of cut fibers were not exposed to the outside that served as the cleaning surface and inclined line of stitches were arranged regularly.

Comparative Example 1

Cord-like knitting was obtained similarly to Example 1 except that, instead of the splittable conjugate fiber, synthetic filament of round cross section made solely of polyester was used. Volume reduction ratio in the denier reduction process was 12% and fineness of single polyester fiber was about 1.9 decitex. In this cord-like knitting, too, the ends of cut fibers were not exposed to the outside that served as the cleaning surface and inclined line of stitches (loop) were arranged regularly.

Comparative Example 2

Splittable conjugate fiber filament similar to that of Example 1 was knitted into an interlock structure using a circular knitting machine (shuttle diameter about 110 cm, 40 gauge) so as to make a grey fabric (wale 60, course 60) that was then opened. The grey fabric was immersed in a processing solution under the conditions described below and left to stand still to undergo denier reduction process, followed by washing in warm water of 80°C, dehydration and drying.

[Conditions of denier reduction]

Processing liquid:

Benzyl alcohol	25%
Nonionic emulsifier	2%
Water	73%

Temperature: 25°C

Duration: 5 minutes

The knitted fabric after processing showed shrunk stitches

(wale 75, course 75). The conjugate fiber that constituted the knitted fabric was divided into eight polyester fibers and one 6-nylon fiber, with fineness of single polyester fiber of about 0.13 decitex.

The knitted fabric described above was cut with heat into thin, long cord 3 mm wide and 1 m long as shown in Fig. 5, washed in ion-exchanged water and then dried. The cord-like knitting thus obtained was a tape about 3 mm wide and 0.4 mm thick, and had hardened bulges (about 0.5 mm wide, refer to Fig. 6) formed on both edges of width during thermal cutting.

Comparative Example 3

Cord-like knitting was obtained similarly to Example 2 except that, instead of the splittable conjugate fiber, a textured yarn made by applying false twisting to the synthetic filament of round cross section that was made solely of polyester was used. The cord-like knitting had a configuration of tape about 4.0 mm in width and about 1.7 mm in thickness. Volume reduction ratio in the denier reduction process was 12% and fineness of single polyester fiber was about 1.2 decitex. In this cord-like knitting, too, the ends of cut fibers were not exposed to the outside that served as the cleaning surface and inclined line of stitches (loop) were arranged regularly.

The samples obtained in the Examples and Comparative Examples as described above were tested to determine the cleaning performance and dust generating characteristic. Total surface

area per unit volume and apparent density of each knitted fabric were calculated with the formulae given below. The results are shown in table 1 and table 2. Fineness of single fiber of the yarn used to constitute the knitted fabrics and angle θ of the stitches of the knitted fabrics are also shown in table 1 and table 2.

[Cleaning performance]

Vaseline spread into a thin film on a glass sheet was wiped off lightly with the sample knitted fabric. Result of vaseline removal was rated in three ranks of $\odot$, $\circ$ and $\times$ based on visual inspection in the order of lowering the degree of vaseline removal. Presence of scratch on the glass surface after wiping was determined by visual inspection.

[Dust generating characteristic]

Dust generation from each sample was measured according to the tumbling method in compliance to IES-RP-CC-003-87-T standard by means of a light scattering particle counter (model C1-500 manufactured by Climet). Average number of particulates observed was calculated from three measurements on each sample.

[Total surface area and apparent density]

[Equation 1]

$$\text{Total surface area} = \frac{S \times (D/d)}{V} \quad \cdots(1)$$

$$\text{Apparent density} = \frac{D/10000}{V} \quad \cdots(2)$$

In the formulae (1) and (2),

D: Total decitex value of cord-like structure

V: Volume (m^3) per 1 m of cord-like structure

S: Total surface area (m^2) per 1 m of component fiber

d: Decitex value of component fiber

[Table 1]

	Example 1	Example 2	Example 3	Example 4	Example 5
Fineness of single fiber (dtex)	0.16	0.16	0.16	0.16	0.16
Stitch angle θ	30	25	25	10	38
Cleaning performance	◎	◎	◎	○	◎
Scratch on wiped surface	None	None	None	None	None
Duct generation (Mean count)	1.2	1.1	1.7	1.3	1.2
Total surface area ($\text{m}^2/1 \text{ m}^3$)	708,790	376,590	329,600	536,280	160,710
Apparent density (g/m^3)	503,980	267,860	239,940	378,550	113,100

[Table 2]

	Comparative Example 1	Comparative Example 2	Comparative Example 3
Fineness of single fiber (dtex)	1.9	0.13	1.2
Stitch angle θ	30	30	30
Cleaning performance	×	◎	×
Scratch on wiped surface	None	Observed	None
Duct generation (Mean count)	1.5	20	1.8
Total surface area ($\text{m}^2/1 \text{ m}^3$)	132,480	421,200	34,700
Apparent density (g/m^3)	609,908	325,000	99,260

INDUSTRIAL APPLICABILITY

The cleaning tool of the present invention, since the cord-like structure of special constitution is used as described above, allows convenient cleaning operation to easily and effectively clean even minute surface irregularities and gaps by simply applying the cord-like structure of the present invention into contact with the minute recesses and inside of the gaps.

In case a knitted fabric or braiding is used as the cord-like structure in the present invention, such a structure as the ends of fibers are not exposed to the outside can be easily obtained. Among such structures, one formed by either circular knitting, tricot knitting or flat knitting is more preferable in view of the cleaning effect.

Use of the cord-like structure of the present invention measuring 2 mm or less in width and 1 mm or less in thickness is preferable since it makes it easier to clean minute gaps and surface irregularities.

Use of the cord-like structure of the present invention wherein stitches appearing on the surface of the cord-like structure are arranged in a direction inclined by an angle of 20° to 90° from the longitudinal direction of the cord-like structure is preferable since such a constitution makes it possible to achieve good cleaning effect by simply moving the cleaning tool in the longitudinal direction of the cord-like structure.

CLAIMS

1. A cleaning tool comprising a cord-like structure formed from yarn, that includes at least in part thereof fine fibers having fineness of single fiber of 1.1 decitex or lower, being knitted or braided into a cord shape so that ends of fibers are not exposed to the outside of the fabric, the cord-like structure having total surface area being from 150000 to 2500000 m² per 1 m³ and apparent density being from 100000 to 700000 g/m³.

2. The cleaning tool according to claim 1, wherein said cord-like structure is a knitted fabric formed by either circular knitting, tricot knitting or flat knitting.

3. The cleaning tool according to claim 1 or 2, wherein sizes of said cord-like structure are set to 2 mm or less in width and 1mm or less in thickness.

4. The cleaning tool according to any one of claims 1 to 3, wherein stitches appearing on the surface of the cord-like structure are arranged in a direction inclined by an angle of 20° to 90° from the longitudinal direction of the cord-like structure.