

D E S C R I P T I O N

Title of Invention RUBBER ROLLER FOR FILM

5 Technical Field

The present invention relates to a rubber roller for film.

Background Art

10 Films are thin synthetic products formed with a polymer compound as main raw material. Films for packaging, optical use, photography, movie, and film having specific functions, and so on, are widely used for various purposes.

15 Generally, films can be manufactured through, for example, a stretching method, calendaring method, extrusion method, and solution casting method. If needs be, a secondary processing, surface treatment, and multilayering processing may be performed with respect to the manufactured film. In such a manufacturing process and processing of films, a lot of rubber rollers are used to handle the films.

20 An automatic film winding device is disclosed in Patent Literature 1. The automatic film winding device automatically or semi-automatically performs a winding process of a film onto a core, and subsidiary processes such as a mounting process of the core to a winding shaft, a winding process, a cutting process of the film after winding process, and dismounting of the core from the winding shaft. In Patent Literature 1, for example, a film conveyor roller having a foam rubber material as the film contacting surface is disclosed.

25 For example, when films are used in electronic devices, they achieve desired effects by transmitting, reflecting, and/or absorbing light rays in most cases. Such films are generally referred to as optical films. Since optical films are used in such technical purposes, factors such as size accuracy of the film and

scratch/contamination prevention in the manufacturing process are highly important to meet the requirements for their optical performance.

Meanwhile, in the film manufacturing process and processing lines, in connection with an improvement of the line speed and thinning into film, the phenomenon of scratching by slipping of the film happens occasionally in places, by reason that the rotation speed of the rubber roller and the feeding speed of the film are not synchronized and the film often slips on the roller by which the film is scratched.

Furthermore, especially, a soft-thin-film is in a dilemma, smaller tension leads it into a slippage and larger tension leads it into stretching of the film.

Citation List

Patent Literature 1: WO2008047546

Summary of Invention

Technical Problem

In consideration of the above condition, the present invention presents a rubber roller for film which possess such a stable gripping force on a film to prevent scratching of the film and applies sufficiently low tension to the film to prevent stretching of the film in feeding.

Solution to Problem

To solve the above problem, a rubber roller for film includes a roller body; and a coating layer provided on the roller body as an outermost layer; the rubber roller characterized in that; the coating layer includes a rubber material and a plurality of hollow microparticles disposed in the rubber material, each formed of a thermoplastic resin; the hollow microparticles have an average diameter of 500 μm or less; the hollow microparticles in the surface side of the coating layer is opening at the surface; the end faces of the opening are flush with the surface of the coating layer; and inner surfaces of the microparticles

opening form concavities on the surface of the coating layer.

Advantageous Effects of Invention

5 According to the rubber roller for film of the present invention produces a stable film gripping force to prevent scratching of the film and a applying low tension to the film to prevent stretching of the film in feeding.

Brief Description of Drawings

10 FIG. 1 is a perspective view of a rubber roller for film of an embodiment.

FIG. 2 is a cross-sectional view of a coating layer of the embodiment shown in an enlarged manner.

15 FIG. 3 is a schematic view which shows a winding process of a film in a roll shape performed by a film winding device.

Brief Description of Embodiments

Hereinafter, embodiments will be explained in detail.

20 A rubber roller for film will be explained with reference to FIG. 1. A rubber roller for film 10 includes a cylindrical roller body 11, coating layer 12 which is forming an outermost layer of the rubber roller for film 10 along the peripheral surface of the roller body 11, and two shafts 13a and 13b extending
25 from the both ends of the roller body 11, respectively.

A material for the roller body 11 may be formed of a material of high stiffness. The roller body 11 may be formed of, for example, carbon fiber-reinforced plastic (FRP), aluminum alloy, stainless steel, or
30 iron. Carbon FRP is preferred.

The shafts 13a and 13b are sometimes referred to as journal. The shafts 13a and 13b are used to bear the ends of the roller body 11 and/or to engage in a drive mechanism, and they have diameters and lengths
35 selected for these purposes. The ends of the shafts 13a and 13b may further be modified to suit their

purposes. The roller body 11 and the shafts 13a and 13b may be formed integrally or may be formed separately and combined together for the use.

5 The structure of the coating layer 12 will be explained with reference to FIG. 2. FIG. 2 is a cross-sectional view of the coating layer 12 of the rubber roller for film 10 of FIG. 1, shown in an enlarged manner.

10 The coating layer 12 includes a rubber material 121 and a plurality of hollow microparticles 122. The hollow microparticles 122 are dispersed in the rubber material 121. The plural hollow microparticles 122 include hollow microparticles 122a positioned in the surface side of the coating layer 12 and hollow
15 microparticles 122b positioned inside the rubber material 121. Hollow microparticles 122a are cut along a curved surface 12a of the coating layer 12 and are partly removed, thereby each has an aperture shape. Such a shape of the hollow microparticles 122a opening
20 on the surface 12 may be referred to as a spherical crown. The section of a hollow microparticle 122a (that is, opening end face 122aa of a spherical crown shape) is flush with the surface of the rubber material 121. That is, hollow microparticles 122a form
25 concavities 122c on the surface 12a of the coating layer 12 such that the inner surfaces of hollow microparticles 122a become part of the surface 12a of the coating layer 12. On the surface 12a of the coating layer 12, a plurality of microconcavities 122c
30 are formed separately from each other by plural hollow microparticles 122a opening on the surface 12a. With plural concavities 122c, the surface of the coating layer 12 is rough surface. On the other hand, hollow microparticles 122b inside the rubber material 121 are
35 spherical. The shape of a hollow microparticle 122b may be a sphere or may be a slightly deformed sphere which does not affect the size distribution.

The surface roughness (Ra) of the coating layer 12 should be 0.3 or more according to the JIS B0601-1994 standard for surface roughness; however, no limitation is intended thereby. For example, the surface roughness may be 0.3 to 42.00 according to JIS B0601-1994, or preferably, 2.50 to 41.50, or more preferably, 2.75 to 41.25. Furthermore, values of the surface roughness of the surface of the coating layer 12 may have distribution, that is, may vary (hereinafter may be referred to as roughness variation). Such roughness variation of the surface may be set to ± 1.0 of the median value thereof, preferably ± 0.5 of the median value, or more preferably ± 0.3 of the median value. For example, the surface roughness (Ra) of the coating layer 12 may be within a range of 0.3 to 42.00 and roughness variation may be from a value of the median value plus 0.3 to a value of the median value minus 0.3. If the median value of the surface roughness of the coating layer 12 is 0.6 to 41.7, values of the surface roughness of the coating layer 12 may have distribution of ± 0.3 of the median value, that is, may vary within ± 0.3 of the median value. If roughness variation is set to a range of ± 1.0 , stable gripping force which does not cause any technical difficulty in the use of a rubber roller can be acquired. If roughness variation becomes smaller, the gripping force becomes more stable, and thus, roughness variation should be ± 0.5 or more preferably ± 0.3 , for example.

The surface roughness (Ra) of the coating layer 12 is measured by a surface roughness measurement device conforming to the JIS B0601-1994 standard. For example, the surface roughness (Ra) can be measured by a surface roughness measurement device from Mitutoyo Co., Ltd. with, for example, a cutoff value: 0.8 and number of sections: 3.

The specific gravity of the coating layer 12 should be less than 1.7, or preferably, less than 1.1.

The specific gravity should be set as small as possible, as long as the coating layer suitably functions in a rubber roller.

5 In the coating layer 12, a suitable volume ratio between the rubber material 121 and hollow microparticles 122 can be determined as a porosity on the basis of the following formula.

$$\text{Porosity} = [\text{Volume of hollow microparticles}] / [\text{Whole volume of coating layer}] \times 100$$

10 The volume ratio as the porosity above should be determined such that the porosity above becomes 10% to 90%, or preferably 20% to 70%, or more preferably, 30% to 60%.

15 Structured as above, even if the surface of the coating layer is worn away during the use of the rubber roller, the hollow microparticles in the proximity of the surface of the rubber material are ground along with the rubber material, and the hollow microparticles open on the surface of the coating layer in sequence.

20 Therefore, concavities which can achieve certain surface roughness are constantly formed on the surface of the coating layer. Therefore, condition of the surface of the coating layer can be maintained for a long period. Herewith, a stable gripping force for a

25 long period can be acquired. Such a surface structure of the coating layer is suitable for feeding a film. That is, the rubber roller with the above-described coating layer can feed a film securely and satisfactorily even with using lower tension, and in

30 the feeding, the film is not scratched and the detachment of the film from the roller is easy since there is not electrostatic unevenness on the surface. Furthermore, since the coating layer includes the hollow microparticles disposed in the rubber material,

35 the specific gravity of the coating layer is decreased, the thus, the rotation of the rubber roller can be performed with lower torque. Furthermore, since the

specific gravity is small, the rubber roller does not produce much heat even in high-speed rolling and expansion of the coating layer is prevented during its operation. Therefore, the rotation speed of the rubber roller is easily controlled during its operation. Moreover, the stiffness of the rubber roller is sufficient to eliminate or reduce rubber fragments generated by damage on the rubber roller.

The base rubber for the rubber material 121 may be, for example, natural rubber, isoprene rubber, butadiene rubber, styrene-butadiene rubber, acrylonitrile-butadiene rubber, butyl rubber, chloroprene rubber, epichlorohydrin rubber, fluororubber, ethylene propylene rubber, acrylic rubber, silicone rubber, polyurethane rubber, or chlorosulfonated polyethylene, or may be formed of a combination of two or more rubbers selected from the above. The hardness of the rubber material 121 should be 90 or less according to the JIS-A standard for hardness, or preferably between 30 to 90, or more preferably between 50 to 80; however, no limitation is intended thereby. A material the JIS-A hardness of which is over 90 may be used for the rubber roller for film by any other condition such as material of the base rubber.

The hardness is measured by a type-A durometer conforming to the JIS K6253 standard. Specifically, the hardness may be measured by any JIS-A hardness measurement device, for example, the JIS-A hardness measurement device from Kobunshi Keiki Co., Ltd.

The hollow microparticles 122 are formed of, for example, thermoplastic resin. The thermoplastic resin may be a copolymer of methacrylonitrile and acrylonitrile, homopolymer of vinylidene halide, copolymer containing vinylidene halide as its monomer, fluoroplastic, polyacrylic etherketone, nitrile resin, polyamide-imide, polyarylate, polybenzimidazole,

polycarbonate, thermoplastic polyester, polyetherimide, polyamide, polymethylpentene, or chlorinated polyvinyl chloride, or may be a combination of two or more materials selected from the above.

5 The hollow microparticles 122 may be formed by heating thermal-expansive microparticles which are highly thermal resistive and solvent resistive. Such thermal-expansive microparticles have an outer shell of thermoplastic resin and a forming agent in the outer
10 shell to be vaporized by heating. The forming agent is a material to be vaporized by heating, and may be linear, branched, or alicyclic liquid hydrocarbon having carbon number 4 to 20 such as propane, butane, pentane, hexane, heptane, octane, nonane, decane,
15 undecane, dodecane, and/or tridecane. When thermal-expansive microparticles containing liquid hydrocarbon are heated to form the hollow microparticles 122, a hydrocarbon gas is contained therein.

 The hollow microparticles 122 should have an
20 average particle size of 5 to 500 μm , or preferably, 10 to 500 μm . If the average particle size is below 10 μm , a stable gripping force may not be acquired depending on the compounding ratio of the rubber material 121 and the hollow microparticles 122. For
25 example, if the average particle size is below 10 μm and the surface roughness (Ra) of the coating layer 12 is below 0.3, escape of air between the film and the coating layer 12 becomes insufficient, and air slippage will be caused. Thus, a stable gripping force may not
30 be acquired. If a film is handled on such a rubber roller, film slippage cannot be reliably prevented. Furthermore, for example, if the average particle size is above 500 μm , concavities cannot be formed uniformly on the coating layer 12 and sufficient stiffness of the
35 rubber roller cannot be achieved.

 As such hollow microparticles 122, conventionally-known preliminarily-expanded microballoons or plastic

microballoons can be used preferably. Such preliminarily-expanded microballoons are available as, for example, Matsumoto microspheres (registered trademark) F-E and F-DE from Matsumoto Yushi-Seiyaku Co., Ltd. If unexpanded microballoons are used, the expansion speed of microballoons and the vulcanizing speed of raw rubber material are difficult to control, and thus, hollow microparticles having uniform particle size are difficult to achieve.

A rubber roller for film is, for example, manufactured as follows. First, a roller body is prepared to have desired length and diameter, and desired shafts attached thereto. Then, a blast treatment is performed on the surface of the roller body. On the other hand, raw rubber material and hollow microparticles consisting of desired material are kneaded in a desired mixture ratio to prepare an unvulcanized rubber sheet. An adhesive agent is applied to the blasted part of the roller body, and the unvulcanized rubber sheet is wrapped therearound, and the shape thereof is adjusted.

It is vulcanized. After that, the surface of the vulcanized rubber formed around the roller body is polished. Herewith, a coating layer is formed around the roller body. When the surface of the vulcanized rubber is polished, the hollow microparticles in the surface side of the rubber material are partly ground along with the rubber material. The polish of the surface of the vulcanized rubber is performed concentrically with the roller body. The hollow microparticles are ground along with the rubber material, and are partly cut and removed by a curve along the polish surface to open on the surface. That is, on the surface of the coating layer, hollow microparticles opening are formed to be flush with the surface. The inner surfaces of the hollow microparticles opening on the surface are exposed

outside through the opening. Therefore, the surface of the coating layer possesses roughness by a plurality of separated concavities which are the inner surfaces of the hollow microparticles opening thereon.

5 The raw rubber material may include a base rubber and a desired additive such as a vulcanizing agent, vulcanizing assist agent, antioxidant, processing aid, filler, and/or plasticizer.

10 The compounding ratio between the base rubber and the hollow microparticles should be, for example, set to 100 parts by weight of the base rubber to 1 to 100 parts by weight of hollow microparticles where the average particle size of the hollow microparticles is 10 to 500 μm . If the coating layer is formed with this
15 compounding ratio, the surface roughness (Ra) of the coating layer 12 is within a range of 0.3 to 42.00 according to the JIS B0601-1994 standard for surface roughness in most cases. The average particle size and
20 compounding ratio of the hollow microparticles should be adjusted such that the specific gravity of the coating layer 12 is less than 1.7 while maintaining the above condition. Here, the porosity of the coating
25 layer 12 can be changed arbitrarily by adjusting the average particle size and mixture ratio of the hollow microparticles. Furthermore, the compounding ratio of the base rubber and the hollow microparticles is
30 considered to be basically constant during the manufacturing process of the rubber roller. Therefore, if the base rubber and the hollow microparticles are mixed in a ratio of 100 parts by weight to 1 to 100 parts by weight in the manufacturing process, the same ratio, that is, 100 parts by weight of the rubber material to 1 to 100 parts by weight of the hollow microparticles is maintained in the rubber roller as a
35 final product.

 An example of use of the rubber roller for film will be explained with reference to FIG. 3. FIG. 3 is

a schematic view which shows a process of winding a film in a roll onto a center-drive film winding device. A film winding device 30 includes a guide roller 31, contact roller 32, and winding shaft 33. A cylindrical core 35 is attached outside the winding shaft 33 and a film 34 is wound around the perimeter of the core 35. The guide roller 31 supports the film to prevent its wrinkling and feeds the film upstream in a suitable direction and/or at a suitable angle for feeding. The contact roller 32 is arranged above the core 35 to tangentially contact the outermost surface of a film roll 36 formed by winding the film 34 around the core 35. Thus, during the formation of the film roll 36 by repeatedly winding the film 34 around the core 35, the contact roller 32 prevents wrinkling and twisting of the film 34 and also prevents air from entering between the film 34 and the outermost surface of the film roll 36.

The rubber roller for film of the present application may be used as a guide roller and/or contact roller in such a center-drive film winding device. Or, the rubber roller for film of the present application may be used as any roller of any other publically-known film winding devices such as a surface drive winding device, or may be used as a roller which contacts a film in any other film handling devices. That is, the rubber roller for film of the present application is interpreted as a rubber roller which directly contacts and handles a film during manufacturing or processing processes of the film.

The rubber roller of the present application can be used for a longer period, more easily controllable during fast rotation, operated with more stable gripping force, less detachment of the film from the roller and less scratching of the film, and can prevent the film from slipping in contact with the roller by reducing electrostatic unevenness on the surface

thereof, as compared to conventional products. The rubber roller of the present application is thus used suitably as a roller contacting a film during manufacturing and/or processing processes of the film.

5 [Examples]

A rubber roller for film of the embodiment and comparative rubber roller were manufactured and compared.

(1) Manufacture of rubber rollers

10 Example 1

A raw rubber material, hollow microparticles, and core were prepared. The raw rubber material included 100 parts by weight of acrylonitrilebutadiene rubber (NBR polymer) as a base rubber, 5 parts by weight of zinc oxide, 1 part by weight of stearic acid, 60 parts by weight of silica, 40 parts by weight of Bis(2-ethylhexyl)phthalate (DOP), 1 part by weight of 2, 6-di-tert-butyl-4-methylphenol (BHT), 1 part by weight of N-Cyclohexyl-2-benzothiazole sulfenamide (CBS) as a vulcanizing promoter, and 1.5 parts by weight of sulfur. As hollow microparticles, Microballoons having an average particle size of 100 μm from Matsumoto Yushi-Seiyaku Co., Ltd. were used.

As a core, a carbon FRP core including a roller body and shafts on the both ends of the roller body was prepared. The roller body had a diameter of 50 mm and a length of 450 mm.

An unvulcanized rubber sheet was prepared by kneading 100 parts by weight of raw rubber material and 1 part by weight of microballoons. A blast treatment was performed on the circumferential surface of the roller body of the core. An adhesive agent was applied to the blasted surface and the unvulcanized rubber sheet was wrapped therearound at that place. The shape of the sheet was adjusted and the sheet was vulcanized. Then, the surface of the vulcanized rubber formed around the roller body was polished. Through the above

process, a rubber roller was formed. The rubber roller was subjected to the following test as example 1. The rubber roller had a diameter of 70 mm.

Example 2

5 A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding ratio except that 10 parts by weight of microballoons having an average particle size of 100 μm were used. The rubber roller was subjected to the following test
10 as example 2. The rubber roller had a diameter of 70 mm.

Example 3

 A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding
15 ratio except that 40 parts by weight of microballoons having an average particle size of 100 μm were used. The rubber roller was subjected to the following test as example 3. The rubber roller had a diameter of 70 mm.

20 Example 4

 A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding ratio except that 100 parts by weight of microballoons having an average particle size of 100 μm were used.
25 The rubber roller was subjected to the following test as example 4. The rubber roller had a diameter of 70 mm.

Example 5

 A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding
30 ratio except that 110 parts by weight of microballoons having an average particle size of 100 μm were used. The rubber roller was subjected to the following test as example 5. The rubber roller had a diameter of
35 70 mm.

Example 6

 A rubber roller was formed in a manner similar to

example 1 with the same materials and same compounding ratio except that 110 parts by weight of microballoons having an average particle size of 5 μm were used. The rubber roller was subjected to the following test as example 6. The rubber roller had a diameter of 70 mm.
Example 7

A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding ratio except that 10 parts by weight of microballoons having an average particle size of 500 μm were used. The rubber roller was subjected to the following test as example 7. The rubber roller had a diameter of 70 mm.

Comparative example 1

A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding ratio except that microballoons were not used. The rubber roller was subjected to the following test as comparative example 1. The rubber roller had a diameter of 70 mm.

Comparative example 2

A rubber roller was formed in a manner similar to example 1 with the same materials and same compounding ratio except that 10 parts by weight of microballoons having an average particle size of 5 μm were used. The rubber roller was subjected to the following test as comparative example 2. The rubber roller had a diameter of 70 mm.

Comparative example 3

In a manner similar to example 1 with the same materials and same compounding ratio except that 10 parts by weight of microballoons having an average particle size of 600 μm were used, preparation of a rubber roller was performed; however, the coating layer was cracked, and a rubber roller could not be formed.

Comparative example 4

As a core, a carbon FRP core including a roller

body and shafts on the both ends thereof was prepared. The roller body had a diameter of 50 mm and a length of 450 mm. A convex/concave polymer tape (rubber strip KS-3 from Kureha Elastomer Co., Ltd.) was applied to
5 the entire circumferential surface of the roller body of the core in a axially-rotated spiral manner such that edges of the convex/concave polymer tape contact with each other around the roller body. A rubber roller formed as above was subjected to the following
10 test as comparative example 4. The rubber roller had a diameter of 56 mm.

Composition of examples 1 to 7 and comparative examples 1 to 3 are shown in Table 1.

Table 1

Formulating materials	Example 1	Example 2	Example 3	Example 4	Example 5	Example 6	Example 7	Comparative Example 1	Comparative Example 2	Comparative Example 3
NBR polymer	100	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Zinc oxide	5	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Stearic acid	1	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Silica	60	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
DOP	40	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
BHT	1	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Vulcanizing promoter DBS	1	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Sulfur	1.5	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto	Ditto
Microballoon with particle size of 5 μm	-	-	-	-	-	110	-	-	10	-
Microballoon with particle size of 100 μm	1	10	40	100	110	-	-	-	-	-
Microballoon with particle size of 500 μm	-	-	-	-	-	-	10	-	-	-
Microballoon with particle size of 600 μm	-	-	-	-	-	-	-	-	-	10

(2) Surface roughness and specific gravity of coating layer

Using examples 1 to 7 and comparative examples 1 and 2, the surface roughness and the specific gravity of the coating layer were measured. The surface roughness of each example was measured by a surface roughness measurement device (from Mitutoyo Co., Ltd.) conforming to the JIS B0601-1994 standard with a cutoff value 0.8, and the number of sections 3. The specific gravity of each example was measured by a specific gravity measurement device using a 50 × 50 mm square piece with 10 mm thickness extracted from the coating layer of each example. Table 2 shows the results.

Table 2

	Example 1	Example 2	Example 3	Example 4	Example 5
Median value of surface roughness (Ra)	3.75	4.85	8.21	16.21	16.32
Specific gravity of coating layer	1.08	0.86	0.76	0.74	0.54
Problem during operation, etc.	None	None	None	None	None (worn easily)
	Example 6	Example 7	Comparative Example 1	Comparative Example 2	Comparative Example 3
Median value of surface roughness (Ra)	2.50	40.25	0.62	0.28	Manufacture failed
Specific gravity of coating layer	0.78	0.60	1.34	0.84	Manufacture failed
Problem during operation, etc.	None	None	Slipping during operation	Slipping during operation	Coating layer cracked during manufacturing process

The rubber rollers of examples 1 to 7 showed median values of the surface roughness of 3.75, 4.85, 8.21, 16.21, 16.32, 2.50, and 40.25, respectively. The surface roughness variation was in a range of ± 0.3 (that is, -0.3 to $+0.3$). In contrast, the rubber rollers of comparative examples 1 and 2 showed median values of the surface roughness of 0.62 and 0.28, respectively.

The specific gravity of the coating layer of each of examples 1 to 7 was 1.08, 0.86, 0.76, 0.74, 0.54, 0.78, and 0.60, respectively. In contrast, the specific gravity of the coating layer of each of comparative examples 1 and 2 was 1.34 and 0.84, respectively.

(3) Work test

Using the rubber roller of each of examples 1 to 7 and comparative examples of 1, 2, and 4 as a guide roller, the performance was evaluated.

The rubber roller of each example was incorporated into a film rolling/unrolling device as its guide roller, a polypropylene film (PP film) having a thickness of 40 μm was rolled with a tension of 30 N/m, and a line speed of 300 m/min. The rubber roller can be rotated freely in accordance with contact and movement of the film during the operation. In the test, the rotation speed of each rubber roller was measured, and factors such as slippage of the film and the rotation condition of the rubber roller were evaluated. A PP film having a length of 3000 m was wound onto a core in a 10 minute operation, and the device was stopped. This process was repeated five times, and the rubber roller after the five cycles was evaluated as a used rubber roller. The condition of the surface of the used rubber roller was evaluated.

The following result was obtained.
Examples 1 to 7

The rubber roller of each of examples 1 to 7

rotated at a rotation speed of 300 m/min during the operation. No scratch was found on the PP film wound onto the core in each rubber roller. The surface roughness was maintained before and after the use in each rubber roller. Furthermore, problems such as idling, film slippage, and winding failure were not observed in each rubber roller. From the above, the rubber rollers of examples 1 to 7 were estimated to exhibit good gripping performance without scratching of the films. Note that the rubber roller of example 5 showed wear on its surface when it is used for a long period.

Comparative example 1

The rubber roller of comparative example 1 rotated at a rotation speed of 142 m/min during the operation. That is, the rubber roller of comparative example 1 idled during the operation.

Comparative example 2

The rubber roller of comparative example 2 rotated at a rotation speed of 156 m/min during the operation. That is, the rubber roller of comparative example 2 idled during the operation. No significant change was observed on the surface of the roller before and after the use.

Comparative example 4

The rubber roller of comparative example 4 rotated at a rotation speed of 300 m/min during the operation. A striped pattern was observed on the surface of the PP film wound onto the core. The striped pattern was caused by pattern transfer of the convex/concave polymer tape adhered around the roller body in a spiral manner onto the film.

Furthermore, according to an evaluation, if a rubber roller with a convex/concave polymer tape adhered thereto in a spiral manner as in comparative example 4 was used for a long period, gaps between the striped pattern transferred onto the film became wider

with the operation time. This is apparently because the convex/concave polymer tape adhered onto the circumferential surface of the roller body in a spiral manner slid and gaps between the tape edges became wider with the operation.

As is evident from the above, a film can be treated suitably by the rubber roller of the embodiment containing 100 parts by weight of rubber material and 1 to 110 parts by weight of hollow microparticles having an average particle size 5 to 500 μm which open on the coating layer. Furthermore, the rubber roller of the embodiment containing the hollow microparticles having an average particle size of 10 to 500 μm which open on the surface of the coating layer having the surface roughness of 0.3 to 41.00 is especially suitable as a rubber roller for film.

List of Reference Numbers

10: Rubber roller for film

11: Roller body

12: Coating layer

12a: Surface of coating layer

13a, 13b: Shaft

121: Rubber material

122: Hollow microparticles

122a: Opening hollow microparticle

122aa: End face of opening

122b: Spherical hollow microparticle

122c: Concavity

30: Film winding device

31: Guide roller

32: Contact roller

33: Winding shaft

34: Film

35: Core

36: Film roller

C L A I M S

1. A rubber roller for film comprising:
a roller body; and
a coating layer provided on the roller body as an
5 outermost layer,
the rubber roller characterized in that;
the coating layer includes a rubber material and a
plurality of hollow microparticles disposed in the
rubber material, each formed of a thermoplastic resin;
10 the hollow microparticles have an average diameter
of 500 μm or less;
the hollow microparticles in the surface side of
the coating layer is opening at the surface; and
the end face of opening are flush with the surface
15 of the coating layer and that inner surfaces of the
microparticles opening form concavities on the surface
of the coating layer.
2. The rubber roller for film according to
claim 1, characterized in that 1 to 100 parts by weight
20 of the hollow microparticles are dispersed in the
coating layer with respect to 100 parts by weight of
the rubber material.
3. The rubber roller for film according to
claim 1 or 2, characterized in that the coating layer
25 has a JIS B0601-1994 surface roughness of 0.3 or more,
and the range of the surface roughness is from a value
of a median value minus 1 to a value of a median value
plus 1.
4. The rubber roller for film according to any
30 one of claims 1 to 3, characterized in that the average
diameter of the hollow microparticles is 10 μm to
500 μm .
5. The rubber roller for film according to any
one of claims 1 to 4, characterized in that the coating
35 layer has a specific gravity of less than 1.7.
6. The rubber roller for film according to any
one of claims 1 to 5, characterized in that the coating

layer has a porosity of 10% to 90%.

7. The rubber roller for film according to any one of claims 1 to 6, characterized in that the rubber material has a JIS-A hardness of 90 or less.

5 8. The rubber roller for film according to any one of claims 1 to 7, characterized in that the thermoplastic resin is acrylonitrile copolymer.