

Comparative Studies on Cellulose Acetate

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I

Acetate "silk" being the youngest child of the rayon industry has to stand many a criticism. Some people claim it is too expensive, the tensile strength is supposed to be inferior, others scrutinize its instability in hot ironing and, finally, its sensibility against alkalis as well as against certain laundering and cleansing agents.

Admitting that these disadvantages exist to a limited degree it can be stated on the other hand, that remedies exist which permit to overcome these fallibilities entirely or almost entirely.

For instance, the weakening caused by hot ironing can be eliminated by pressing the material on the reverse side not moist but half dry with only a fairly hot iron. Every woman knows nowadays how her Celanese garments have to be treated in order to preserve the material and its gloss.

Also the sensitiveness of cellulose acetate towards alkali and washing and cleansing agents should not be exaggerated as is occasionally done. No women would dare to boil her woollens and silks with a powerful alkali; and so, naturally, also certain care should be exercised with cellulose acetate.

It is essential to consider here the chemical character of this textile material, and to avoid such chemicals which are detrimental to the gloss or which may cause a deterioration or even solution of the material. Such chemicals are, for instance, caustic alkalis, hot soda solutions, chloroform, and the like. The manufacturer of "Persil," a washing powder popular in Germany, demands with justified reasons, that this product for washing rayon fabrics should not be applied hot, but in a cold bath.

As far as the dry-cleaning agents (spotting agents) are concerned no doubt exists in regard to gasoline or to the so-called solvent soaps of carbontetrachloride (Tetrapol) or trichlorethylene. The larger dry-cleaning establishments are well acquainted with these facts

and they have adopted such methods which are safe to use for all kinds of rayon—inclusive of the acetate type—permitting a simple cleaning procedure and using harmless agents.

As far as the inferior tensile strength of acetate cellulose is concerned this shall be discussed later on.

But what are all these minor drawbacks and inconveniences compared with the great number of advantages which this yarn possesses?

These are, among others:

1. The excellent smoothness, softness and flexibility of the thread and its silklike feel.
2. The quiet dull lustrous gloss resembling natural silk.
3. The high elasticity combined with a good tensile strength, in connection with an excellent resistance to crushing.
4. The high resistance to water and moisture and hence the good fastness to washing.
5. The low specific gravity.
6. An affinity to dyestuffs different from other textile fibers.
7. Valuable sanitary properties.

We think it is justifiable to get into more details as to the above mentioned points.

Smoothness and Dull Luster

The excellent smoothness, softness and flexibility of the acetate thread in connection with the quiet dull lustrous gloss are those outstanding properties which make it sometimes difficult, even for the expert, to distinguish it from natural silk by feeling. These properties also comprise the main reason why the somewhat higher selling price of this product is accepted by the buying public.

Tensile Strength

The very high elasticity is of great advantage especially in the weaving process, for instance, in using warps of finer deniers. Important is further the elastic property to snap back almost to its normal length after

* Consulting Chemist.

stretching. It excels, without a doubt, in this regard the other types of rayon. Although it does not come near the elasticity of real silk it can be said that it is equal to that of a medium weighted natural silk. Its increased resistance to crushing based on this elasticity explains its extensive use for velvet and plush of a most rigid pile.

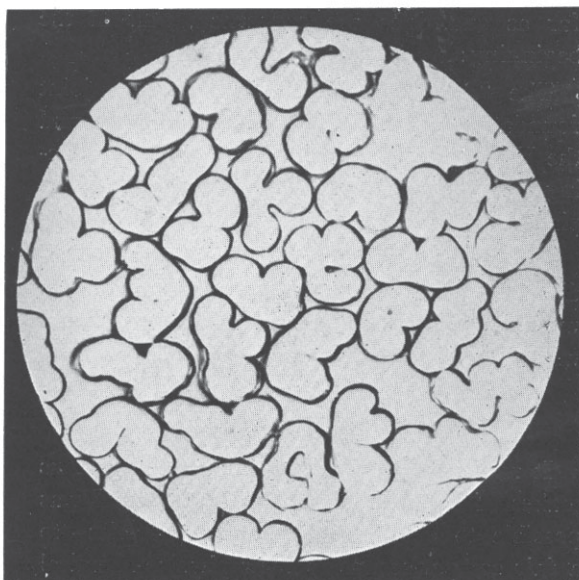


Figure 1
Cellulose Acetate "Setilose" (Belg.)

Fastness to Washing

There have been written so many treatises on the fastness to water of acetate cellulose that we may omit here a further discussion of this subject. This indifference to moisture bears in itself great advantage for the working of the thread into weavings. Atmospheric conditions which sometimes cause unexpected trouble as, for instance, glossy spots in the finished piece are to be expected to a lesser degree than with other types of rayon. In this respect acetate cellulose resembles natural silk to a large degree.

Most valuable is this property in laundering. The dirt cannot enter easily into the very smooth surface of the acetate fiber, because the carrying vehicle, the moisture, is absent; the dirt remains, therefore, on the surface of the woven or knitted material and can be removed without much effort and without danger of

weakening of the fiber during the washing.

That after exposure to water the tensile strength is less diminished than is the case with other types of rayon proves to be a great help in the dyeing and washing. Good cellulose acetate should under such circumstances not become rough or woolly, and should remain of the same beauty and softness as be-

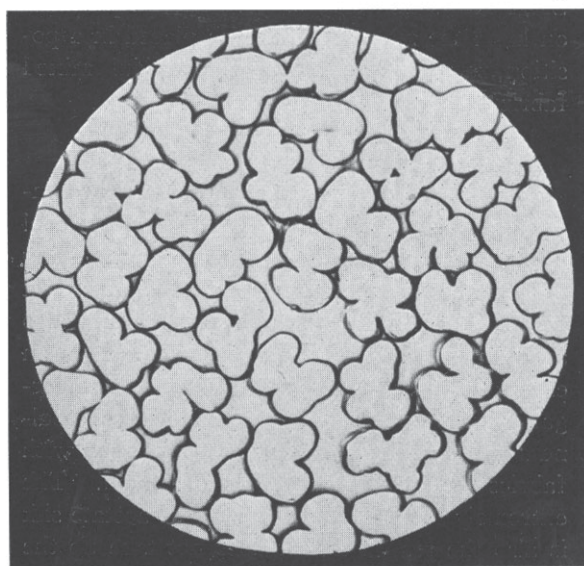


Figure 2
Cellulose Acetate "Celanese" (Eng.)

fore. These advantages easily counterbalance the slightly inferior strength in its dry state which, by the way, is practically identical with most of the commonly offered other rayons.

Specific Gravity

The low specific gravity of acetate cellulose (about 1.30 as compared with 1.50-1.56 of the other types of rayon) gives a large volume at the same denier number and so a fuller appearance to woven or knitted goods.

It is, therefore, only natural that such materials have a lighter and more real silk-like feel. Natural silk boiled-off and not weighted also has the specific gravity of 1.3 or slightly above this figure.

Affinity to Dyestuffs

Of greatest importance is the difference which acetate cellulose shows in the dyeing of

the fiber in comparison with other chemical yarns. Its different affinity towards the ordinary cotton-rayon dyestuff as well as wool and silk dyestuffs—first believed to be a drawback—has later on proven to be an enormous advantage, an advantage not to be underestimated, after the dye manufacturers succeeded in finding a scale of dyestuffs of excellent fastness, *i. e.*, the Cellit and Celliton fast colors, SRA colors and others. With these products on hand the manufacturer was placed in a position to produce the most beautiful mixed fabrics.

Sanitary Properties

Acetate "silk" is—as is proven—a poor conductor for heat and for that reason feels cool in summer and warm in winter. The wearing of acetate undergarments, therefore, affords a perfect balance for climatic changes and also an effective protection against colds. It is an especially pleasant sensation to wear an undergarment made of acetate as a feeling of coolness will be entirely absent in comparison with fabrics made of other types of rayon. The extremely low swelling property of acetate silk is also the reason that it does not take up the moisture of the human body. The perspiration diffuses out through the airy spaces of the woven or knitted fabric. To these hygienic advantages may be added a feature so important for tropical use, namely, that acetate is resistant to vermin and micro-organisms, as we have here before us the acetic acid ester of cellulose and not regenerated cellulose.

With these points the advantages of cellulose acetate are by no means complete. However, the features mentioned may be sufficient to justify our statement that acetate "silk" represents a most valuable product which in its qualities resembles most closely real silk.

This explains why the consumption of this type of rayon is increasing constantly, although it has to be considered that at present we are passing through a rayon crisis which is marked by marketing difficulties as well as by price reductions.

During recent years a considerable number of acetate plants¹ have been erected, notwith-

standing the fact that the principal manufacturer, the British Celanese Co., Ltd., had already the advantage of over 10 years experience in this field. It is estimated that this concern produces about 25,000 lbs. per day, the Celanese Corp. of America, 22,000 lbs. per day, the Canadian Celanese Company, Ltd., about 2,200-4,400 lbs. daily.

In Germany the production of acetate is, as far as quantities are concerned, still in the beginning:

The "Aceta" G.m.b.H. in Berlin, a joint foundation of the I. G. Farbenindustrie and the Vereinigte Glanzstoff-Fabriken, is producing today about 3,300 lbs. per day and has plans of doubling this output by 1931.

Furthermore must be mentioned the "Rhodiaseta," in Freiburg in Breisgau, a concern working with an investment of French capital with a daily production of 2,200 to 2,600 lbs.

II

It may be of interest to subject the various makes of cellulose acetate in as far as it was possible to obtain representative samples—to a fair comparison as to their physico-chemical properties.

Physico-Chemical Properties

As material for these tests I had obtained samples of genuine origin, being of prime quality and of recent manufacture of the following concerns:

- I. Fabrique de Soie Artificielle de Tubize, Brussels, in the following briefly called: "Setilose."
- II. British Celanese, Ltd., London, in the following called: "Celanese."
- III. Société pour la fabrication de la Soie "Rhodiaseta," Rousillon, France, in the following briefly called: "French Rhodiaseta."
- IV. Deutsche Acetat - Kunstseide A.G., "Rhodiaseta" Freiburg i. Br., Germany, in the following called: "German Rhodiaseta."
- V. Aceta G.m.b.H. Berlin, Rummelsburg, in the following briefly called: "Aceta."

¹ See Stadlinger, "Kunst-Seiden-Taschenbuch," 2nd Ed. 1930, p. 245, etc.

We further had at our disposal a few hanks manufactured by:

VI. La Soie de Clairoix S.A., Clairoix, France.

parcel, marked "Drya" first quality made in Holland.

The results of our tests for the cellulose acetate brands I-V are compiled in the follow-

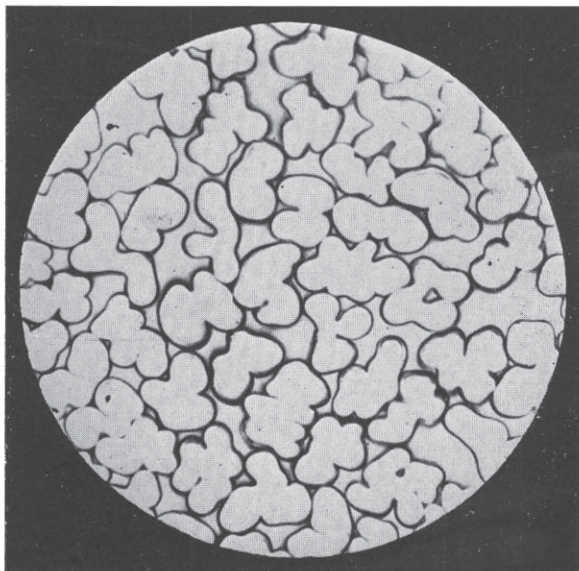


Figure 3
Cellulose Acetate "French Rhodiaseta"

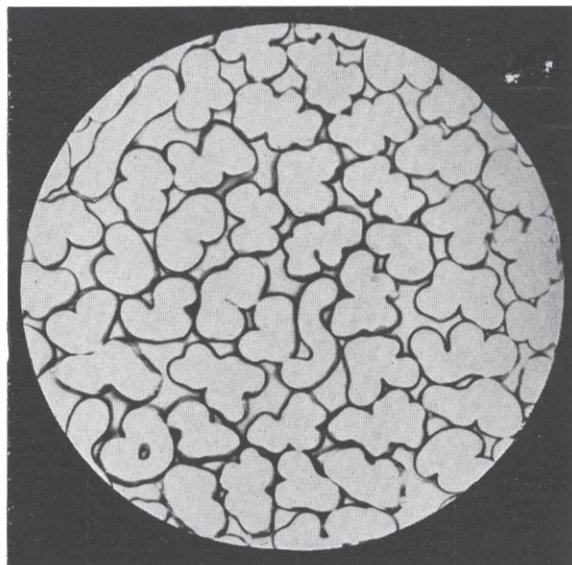


Figure 4
Cellulose Acetate "German Rhodiaseta"

VII. Apex (British) Artificial Silk Co., Ltd., Stratford (England).

VIII. N.V. Nederlandsche Kunstzijdefabriek "Enka Drya" (Netherlands), 10 lbs.

ing table. Details regarding these experiments are given in the accompanying text of the analytical results.

75 denier; 40 filaments per thread; twist 204; breaking strength: dry, 1.12 gr., wet, 0.54 gr. per denier.

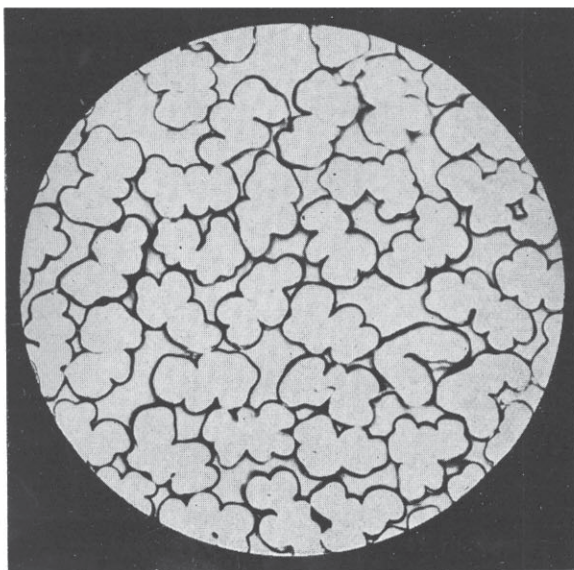


Figure 5
Cellulose Acetate "Aceta" (Berlin, from March, 1930)

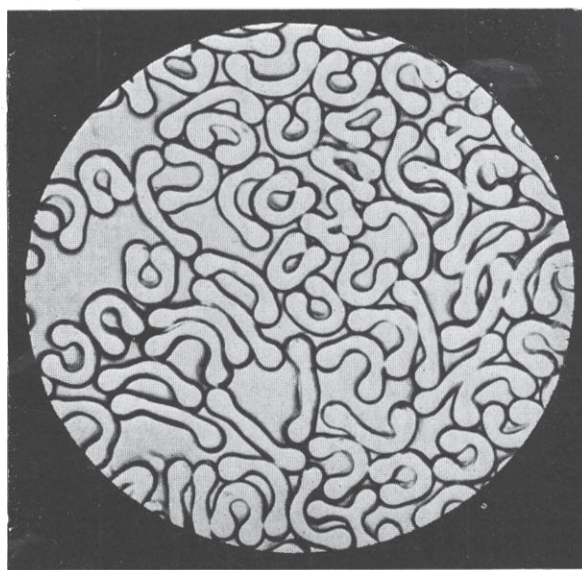


Figure 6
Cellulose Acetate "La Soie de Clairoix S.A." (France)

RESULTS OF TESTS MADE ON 5 ACETATE "SILKS"

Classification	I Setilose (Belgian)	II Celanese (Engl.)	III French Rhodiaseta	IV German Rhodiaseta	V Aceta (German)	
Snarl threads (Cotton Lacings)	2 pink 1 white	4 times white	2 yellow 2 white	2 blue 2 white	1 yellow 5 white	
Fineness Number of Single Threads	75 den. Claimed 20 Found 20	75 den. Claimed 20 Found 20	100 den. Claimed 32 Found 32	75 den. Claimed 24 Found 24	75 den. Claimed 20 Found 20	
Twist (right) (Average of 10 determinations)	200	174	157	220	198	
60% relative humidity at 20°C.	Breaking strength after removal of oil for 1 den. calculated in grams: (a) dry (b) wet (c) First boiled then dried at 20°C. (d) knotted	Strand A 1.22 Strand B 1.23 Strand A 0.64 Strand B 0.62	A 1.23 B 1.22 A 0.64 B 0.64	A 1.26 B 1.24 A 0.76 B 0.77	A 1.31 B 1.35 A 0.77 B 0.79	A 1.34 B 1.33 A 0.90 B 0.89
		1.08	1.08	1.12	1.22	1.36
		Strand A 0.98 Strand B 0.97	A 1.06 B 1.08	A 1.09 B 1.07	A 1.05 B 1.10	A 1.15 B 1.16
		60% relative humidity at 20°C.	Tensile strength or Breaking Elasticity of the acetate silk after removal of oil, in %: (a) dry (b) wet Increase between a and b average (c) Boiled, and dried at 20° C. (d) Knotted	Strand A 29.3% Strand B 27.2% Strand A 34.7% Strand B 32.7%	A 25.0% B 27.0% A 31.3% B 33.0%	A 28.7% B 27.0% A 38.5% B 38.5%
19.5%	23.4%			38.5%	33.0%	39.0%
20.5%	19.4%			21.5%	19.9%	19.9%
Strand A 16.5% Strand B 15.9%	A 16.1% B 19.0%			A 19.5% B 18.3%	A 14.6% B 15.8%	A 18.3% B 18.3%

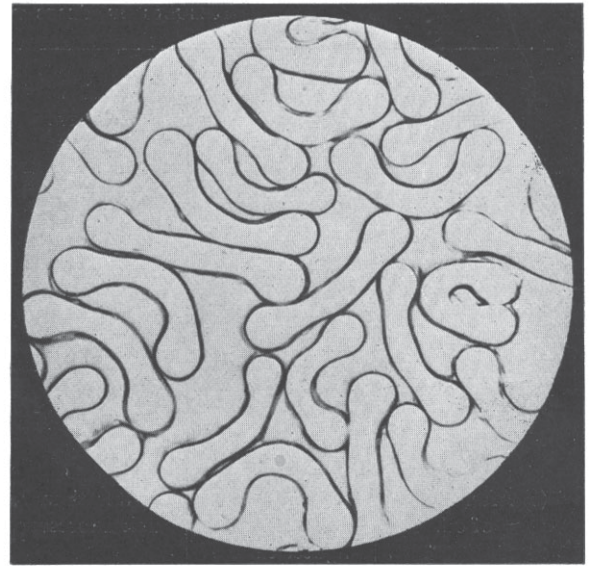
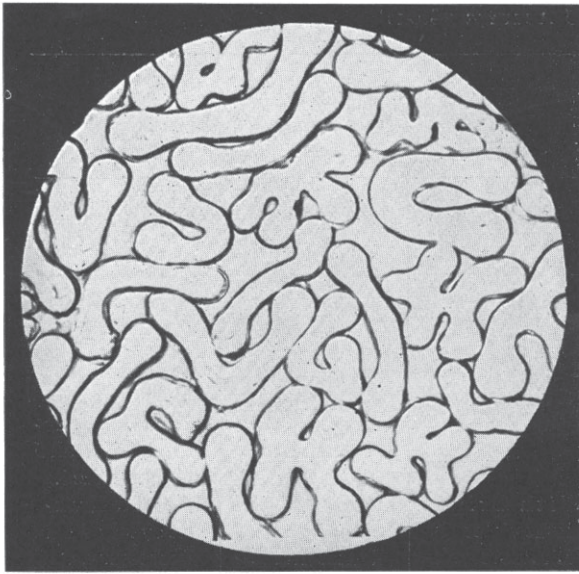


Figure 7
Cellulose Acetate "Brit. Apex Art. Silk" (Eng.)
140 den.; 24 filaments per thread; twist, 190; breaking strength: dry, 1.02 gr., wet, 0.57 gr. p. den.

Figure 8
Cellulose Acetate "Enka-Drya" (Holland)
100 den.; 20 filaments per thread; twist, 214; breaking strength: dry, 1.15 gr., wet, 0.59 gr. p. den.

RESULTS OF TESTS MADE ON 5 ACETATE "SILKS"

Classification	I Setilose (Belgian)	II Celanese (Engl.)	III French Rhodiaseta	IV German Rhodiaseta	V Aceta (German)
60% relative humidity at 20° C. Titer, found in the silk after removal of oil. (Five strands of each brand were drawn); of each brand 5 single parts of 450 each meter were weighed The differences are:	Deniers	Deniers	Deniers	Deniers	Deniers
	76 76 79	72 72 67	101 101 97	73 (Average differences from 70-76)	75 74 75
	75 78	73 71	98 100	74 72 76 74	76 76
	negligible	considerable	negligible	appreciable	negligible
Properties	I Setilose (Belgian)	II Celanese (Engl.)	III French Rhodiaseta	IV German Rhodiaseta	V Aceta (German)
Feel.....	Very soft.	Soft.	Soft.	A little harder than II and III.	Very soft.
Gloss.....	Even, mild.	A little stronger than I, otherwise even.	Still stronger than II, otherwise even.	Dull, somewhat disquiet.	Milder, quiet mellow gloss.

RESULTS OF TESTS FOR 5 ACETATE "SILKS"

Properties	I Setilose (Belgian)	II Celanese (Engl.)	III French Rhodiaseta	IV German Rhodiaseta	V Aceta (German)
Color.....	Almost white.	Slightly yellowish.	Slightly yellowish.	Almost white.	Almost white.
Behavior in ultra-violet light:					
(a) Direct.....	Slightly violet fluorescent.	Somewhat less fluorescent than I.	Slightly violet fluorescent.	The slightest violet fluorescence of all 5 rayons tested.	The strongest violet and very even violet fluorescence of all 5 rayons tested.
(b) After removal of oil.	Grayish violet, dull fluorescent, lighter than V.	Lighter than I, dull fluorescent.	With bright light violet bluish fluorescent.	Similar to II, although yet lighter fluorescent.	With a dull violet evenly dark fluorescent.
Electrical charge in sorting.	Very strong when throwing yarn.	Very strong when throwing yarn.	None.	None.	None.
Results of sorting.	Generally good; some broken-off capillar threads.	In general not quite satisfactory, considerable number of broken-off capillar threads.	Medium, quite a number of broken-off capillar threads. Further breakages occur during throwing; on some, spots nestlike conglomerations of single threads.	Very good; no capillar thread fracture, no "nests."	Very good; no capillar thread fracture, no "nests."
Dyeing experiments with Cel-litfast dyes.	Thread shows the highest dyestuff affinity of all five samples. Threads curl. Feel strawlike flat. Gloss diminished.	Thread shows strong affinity to dyestuffs, especially to Blue. Feel somewhat strawlike. Gloss a little diminished. Shades disquiet.	Affinity to dyestuffs normal. Gloss normal. Hardly curls. Feel good. Color shades quiet.	In coloristic respects same as III; feel a little less soft than III.	Dyestuff affinity good; feel softest of all 5 brands. Gloss illustrious, not loud. Quiet color-shades.
Boiling test.	Appreciable loss in gloss, slightly woolly appearance.	Remarkable loss in gloss at the same time opalescent; strongly woolly appearance.	Rather remarkable loss in gloss with pronounced woolly appearance.	Distinguishable loss in gloss slightly woolly appearance.	Very slight loss in gloss, almost no change as far as woolly appearance is concerned.

RESULTS OF TESTS FOR 5 ACETATE "SILKS"

Test	I Setilose (Belgian)	II Celanese (English)	III French Rhodiaseta	IV German Rhodiaseta	V Aceta (German)
Microscopical cross-section of the capillar threads at 485 times enlargement.	A few lapped, mostly 2-3 lapped forms, rather "full," different in size. Inclination to ribbon-forms apparent. (See picture 1.)	Forms deeper lapped than I, mostly 2-, 3- and 4- lapped. Sizes different in proportion; somewhat irregular. In general "full" forms. (See picture 2.)	Forms partly deep, partly slightly lapped. Sizes of cross-sections very different. Partly 40% off, changing from 4-, 5- and 6- lapped forms to 2- and 3- lapped forms. Inclination to ribbon type apparent. (See picture 3.)	Change between 2-, 3-, 4- and 5- lapped forms. Besides different sized forms. Inclination to ribbon forms noticeable. (See picture 4.)	Generally 4-, 5-, 6- and 7-, lapped forms having a good "fullness." The sizes of the forms are rather equal. (See picture 5.)
Acetic Acid contents (CH ₃ COOH). Average of 2 determinations	53.2%	53.8%	54.4%	54.3%	54.9%
Viscosity (Ost's method) 2% in acetone at 20° C.	5.70% relative viscosity	5.80% relative viscosity	5.55% relative viscosity	5.75% relative viscosity	8.85% relative viscosity
Oil-coating (Extracted with ether)	Strand C 1.3% Strand E 1.4%	C: 3.7% E: 3.4%	C: 2.6% E: 3.0%	C: 4.0% E: 4.3%	C: 2.5% E: 3.0%

(To be continued)