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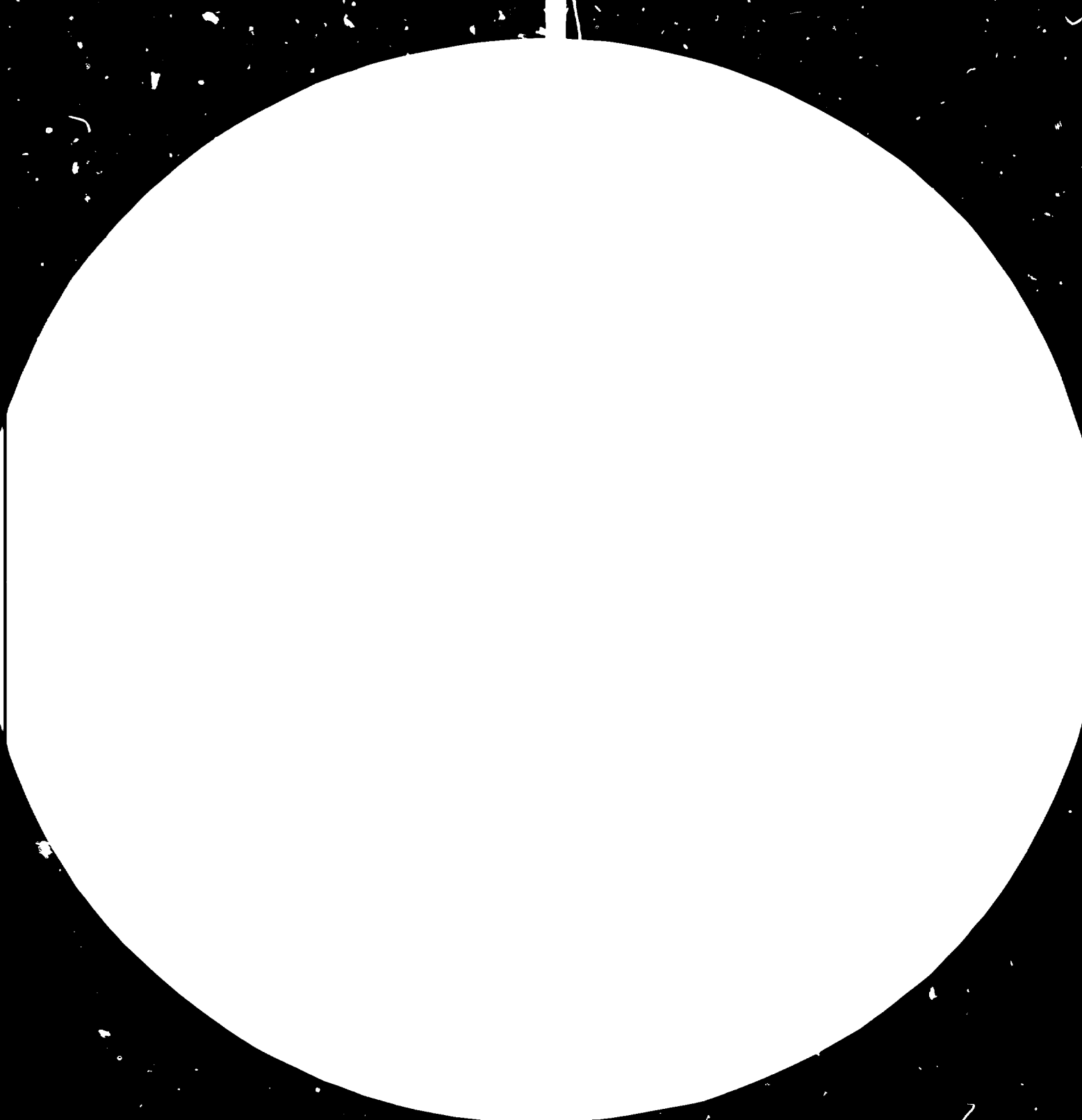

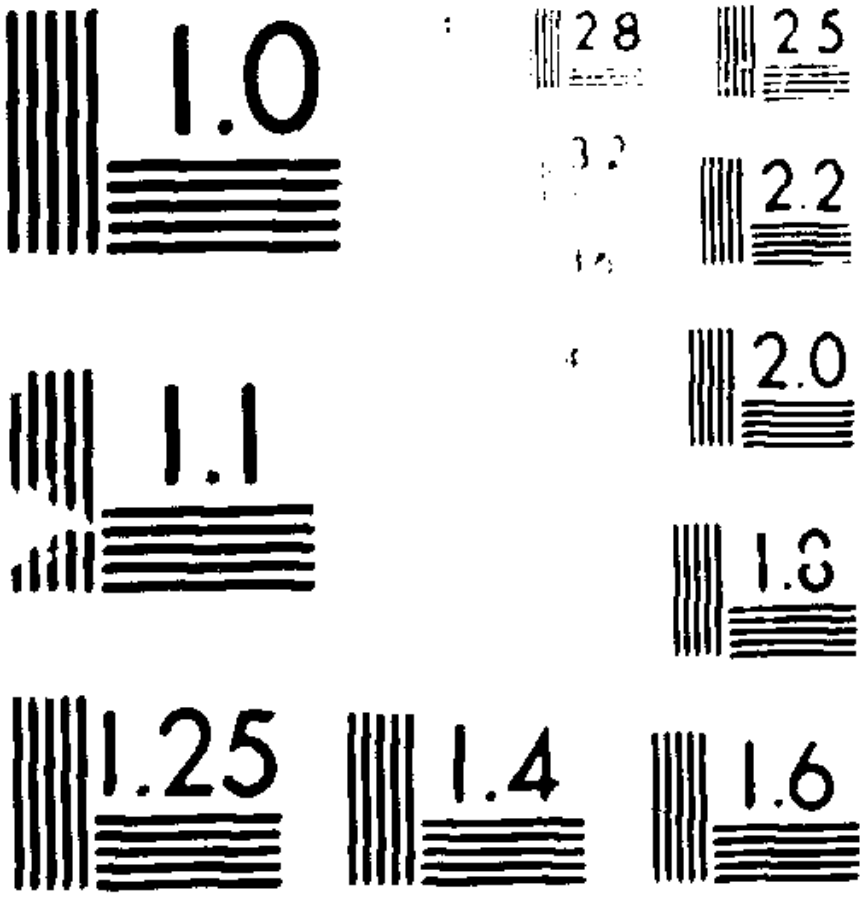

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# The TREVIRA® sortiment - its properties and fields of application

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# The TREVIRA® sortiment - its properties and fields of application

From my previous speaker you heard a lot of the production methods for polyester fibres. I am very pleased to speak to you now on the properties and fields of application of those fibers. Since Hoechst AG is one of the biggest polyester fibre producers in the world and hence its sales program is very extensive,I'll try to give you this survey on the hand of the sales program of TREVIRA , the trade mark of polyester fibres from Hoechst AG. The diversity of uses in various fields has resulted in a large number of types. This leads to a splitting of my remarks into three major sections. I would like to speak first about TREVIRA staple fibres, then about continuous filaments and their fields of use in textiles, and finally about polyester types for industrial purposes. Let's start now with TREVIRA staple fibres.

## I. TREVIRA STAPLE FIBRES

First a short excurse back to cocondensation.
As you heard, polyester fibres are made from two components, a diole and an acid with two reactive groups - usually from ethanediole and terephthalic acid. But you can get also fibres for special purposes by varying one of these components.

® = Registered Trade Mark

| PES – type | Alcoholic component | | Acid component |
|---|---|---|---|
| PET | Ethanediol | —— | Terephthalic acid |
| PBT | Butanediol | —— | Terephthalic acid |
| ®KODEL | Dimethylolcyclohexane | —— | Terephthalic acid |
| ®A – Tell | Ethanediol | —— | p-Oxybenzoic acid |

Components of various Polyesters — ATA-T 639

In slide 1) I show you some possibilities to get polyesters with special properties. PBT e.g. has very good properties in the carpet area, the Kodeltype has a very good creasing resistance and is predominantly used as fibre fill material, whereas A-Tell has a silk like lustre and a high resistance against hydrolysis. This ist probably due to the polyesterether linking. The maintype is by all means still polyethyleneterephthalat.

| Type | | Characterisation |
|---|---|---|
| 120 | Cotton types | Standard type |
| 130 | | Type for sewing threads (high tenacity) |
| 160 | | Low-shrinkage type for cheese-dyeing |
| 210 | Wool types | Carrierless dyeable type |
| 220 | | Standard type |
| 350 | Low-pilling types | Universal type for weaving and knitting |
| 353 | | Trilobal cross-section |
| 440 | Cationic dyeable type | Produced only in USA |
| 520 | High shrinkage type | Industrial end-uses |
| 810 | Carpet types | Carrierless dyeable or deep dye type |
| 820 | | Standard type |
| 823 | | Trilobal cross-section |
| 850 | | High-shrinkage type |
| 860 | "Fibrefill" type | |

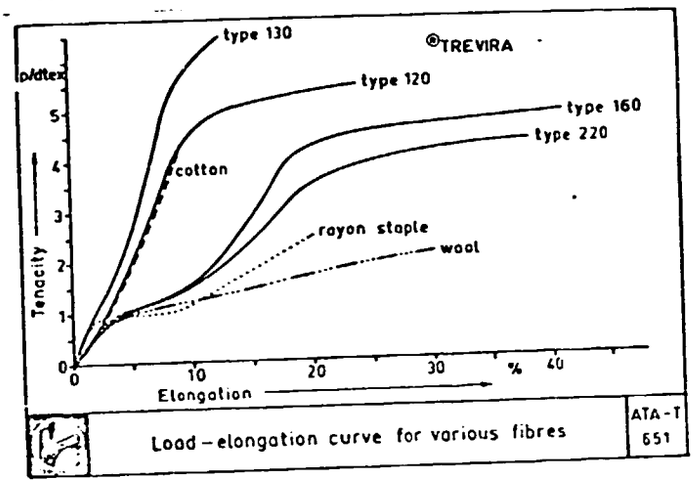
®TREVIRA fibres (range of types) — ATA-T 640

In the second slide, I show you the range of TREVIRA staple fibres which are mainly produced from PET and its modifications. Each of these types can be supplied in several gauges and staple lengths, in bright or dull versions and in some cases in optically brightened (pure white) or spun-dyed black versions. Other spundyed polyesters are especially interesting for big markets because of economic reasons.

Type 120, in its technical textile properties comes close to those of cotton. It ist mainly used as a mixture with this natural fibre. Against this, TREVIRA 220 was developed for

blending with wool or with rayon staple. We describe these two TREVIRA fibres as standard types. But the specific properties of TREVIRA 120 and TREVIRA 220 do not meet the requirements of all various fields of application. Soon attempts were therefore made to modify the polyester fibres physically or chemically.

The most important physical modification is the variation of the stress-strain curve as it is shown in slide 3).

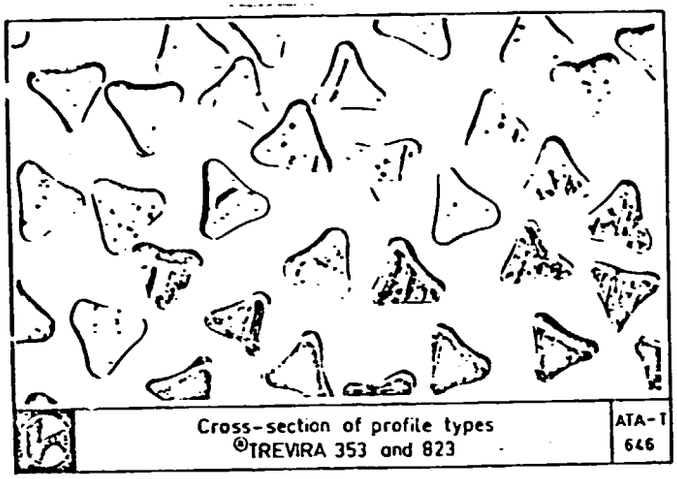



Beside the various TREVIRA types, you find cotton, rayon staple and wool. You see that, in accordance with the field of application, the load-elongation curve of the highly stretched TREVIRA 120 fibre largely matches cotton, while TREVIRA 220 is more similar to wool and rayon in its tensile-elastic behaviour, though it has a much higher fastness.

TREVIRA 130 is especially constructed for the application in sewing threads, so it has a very steep stress-strain curve and in order of its high cristallinity a something lower dyeability.

On the other hand, TREVIRA 160, a mid-tenacity fibre, has a very good dyeability and a reduced shrinkage. Used in a mixed yarn, it can therefore be cheese-dyed or be m-dyed without pre-shrinkage or pre-steaming and is used in mixture with cotton in woven coloured goods.

Another method of physical modification concerns the surface or the cross-section of the fibres. With a trilobal cross-section, as shown in slide 4), you get




fashion effects, as high gloss, glittering and a rough hand. This glittering effect is produced by the specific light refraction at the fibre surface, the intensity is decided by the percentage of TREVIRA 373 present in the mixed yarn.

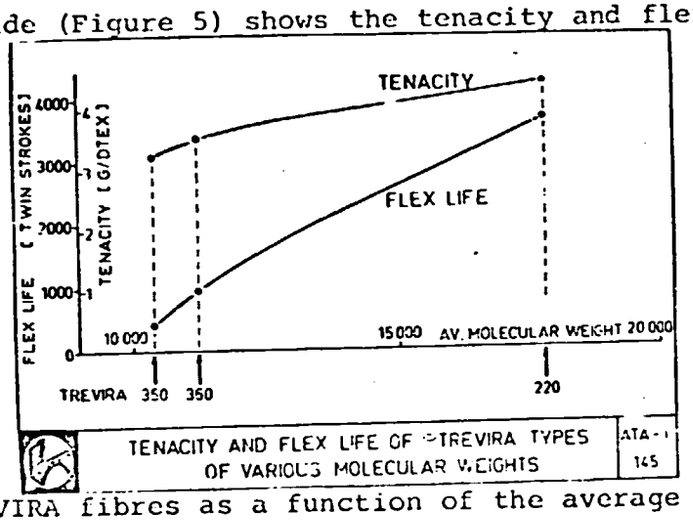
Type 353 is available in gauges of 4.0 dtex and 6.7 dtex, depending on the desired fineness of yarn. In cloth weaving, 20 - 25 % of TREVIRA 353 in the mixture is generally regarded as the optimum. Thus you can get fabrics resembling the quality of kid mohair. Especially the knitters like the elegant lustre of this yarns for coctail-dresses etc.
For carpets, type 823 is used either in 100 % or in mixture with type 820 or with polyamide for bedroom qualities.

Another way of getting special fibre properties is the chemical modification. This concerns above all the dyeability of the polyester fibers. Usually they are dyed by means of a carrier at 100° C or at 125° C without a carrier with disperse dyestuffs. But carriers usually bring problems with the air pollution because of their intensive smell and dyeing at higher temperature costs energy and -hence- money. So Hoechst developed during the last years a so called "carrierless dyeable" polyester type TREVIRA 210 which can be dyed at the boil without any carrier in the same deep shades as the standard type with a carrier. The new fibre can be worked completely as the standard type and is used predominantly for blends with wool but also for the printing sector.

The cotton and wool types TREVIRA 120, 160, 210 and 220, which we have hitherto considered, are used predominantly to produce

labour and leisure wear and smoother, cropped fabrics for women's, men's and children's outer wear. They cannot be used for flannel-like fabrics and for knitted goods because of their tendency of pilling. For this purpose, the market requires low-pilling polyester fibres, that is to say fibres of the minimum possible flex-life. The development of such special types has resulted in an important broadening of the field of polyester fibres.

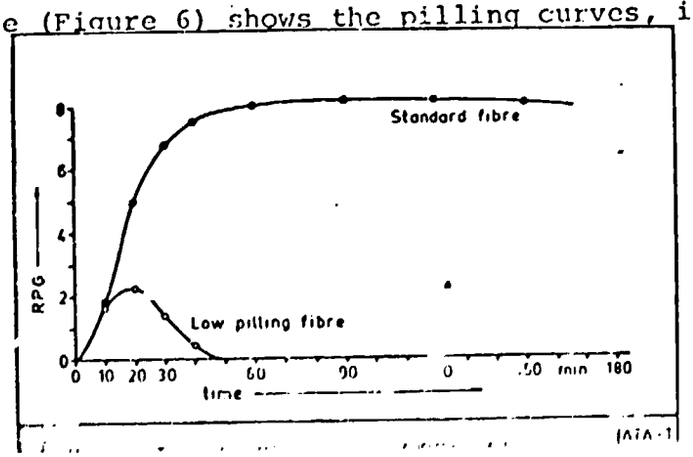
The next slide (Figure 5) shows the tenacity and flex life of




various TREVIRA fibres as a function of the average molecular weight.

As you can see the tenacity of TREVIRA 350 is about 3 p/dtex. It is thus only slightly less than that of TREVIRA 220. On this graph, TREVIRA 360 means an older, only physically modified low-pilling type, which is not any longer in the program, whereas TREVIRA 350 is a chemically modified type. We have tested this polyester fibre in extensive experiments. Since an objective comparison of the tendency to pill in mixed fabrics is not possible, woven and knitted fabrics of 100 % polyester fibres were producedfor these investigations.

The next slide (Figure 6) shows the pilling curves, i.e.

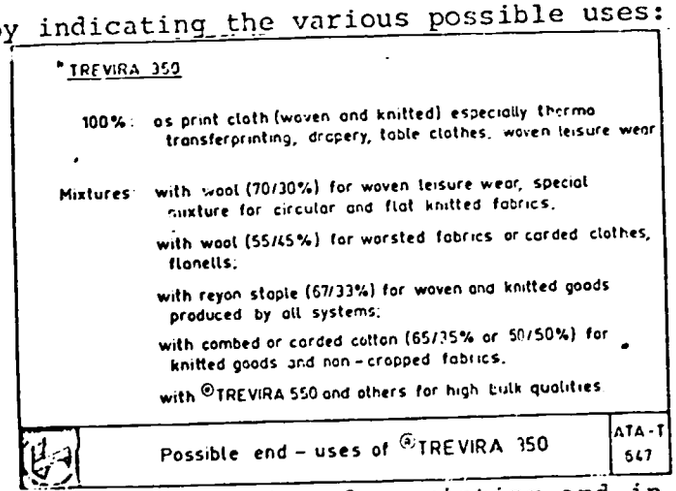


pilling degree versus time, of standard type jersey and the same of TREVIRA 350, the low-pilling polyester fibre. Since TREVIRA 350 meets as good the pilling standards for jerseys, which are much harder than that for woven-fabrics, it can universally be used as well for knitted as for woven goods. Appropriate wearing tests have confirmed these laboratory findings.

Further advantages of this type are a very smooth hand and an improved dyestuff affinity. Regarding the finishing of knitted and woven articles, TREVIRA 350 behaves like our other fibres and does not require any special finishing steps. We supply this fibre in gauges of 1.7 to 6.7 dtex and in staple lengths of 38 to 100 mm, as well in bright, semi-dull and spun-dyed black versions and also as a trilobal type, called TREVIRA 353 which I mentioned before.

It can be worked on all systems, as well cotton, woollen or the new OE-rotor spinning.

The next picture (Figure 7) shows the universal nature of TREVIRA 350 by indicating the various possible uses:




You can use it as 100 % clothes for printing and in knitwear. Mixed with wool, this fibre is converted particularly into dress-, costume-, suiting- and coat fabrics of a flannel-like character. Mixed with rayon, TREVIRA 350 is spun into yarns on the cotton principle, and is predominantly used in the women's outer garment field. TREVIRA 350 is usually blended with cotton in the knitting field for the production of blouses, dresses, underwear and the like, and in the weaving field for pyjamas, sport shirts etc. Furthermore in the knitting field TREVIRA 350 is used as 55/45 and 70/30 % mixtures with wool. Knitted articles

made from 70 % TREVIRA 350 and 30 % wool possess markedly better machine washability and better "easy care" properties. Against this, the 55/45 % blend has a somewhat higher volume.
Since TREVIRA 350 is a very low-pilling fibre, the knitted articles do not have to be cropped or burned, so knitwears remain the smooth touch. Finally, TREVIRA 350 can also be blended with our chemically modified high-shrinkage fibres, with or without the addition of wool. As a result of the high-shrinkage component we get particularly voluminous woven and knitted articles.

Another chemically® modified fibre in our program is TREVIRA 440, a cationic dyeable fibre. Its special application for differential dye effects needs big production batches for economic reasons, so it is only produced in USA. The European market is not yet interested in this type.

Matching the trend towards articles from 100 % synthetics high-shrinkage fibres play an important role in the construction of those articles. With blends containing such fibres you can get voluminous bulky and light-weight TREVIRA articles with a woollen touch.

Our experiments along these lines were first carried out with a physically modified high-shrinkage fibre, TREVIRA 520. (Figure 8).

| Type | Nature of Modification | Field of Use |
|---|---|---|
| ®TREVIRA 520 | Physically modified | Industrial field |
| ®TREVIRA 650 | Chemically modified | Carpet field |

®TREVIRA - High-shrinkage fibres — ATA-T 617

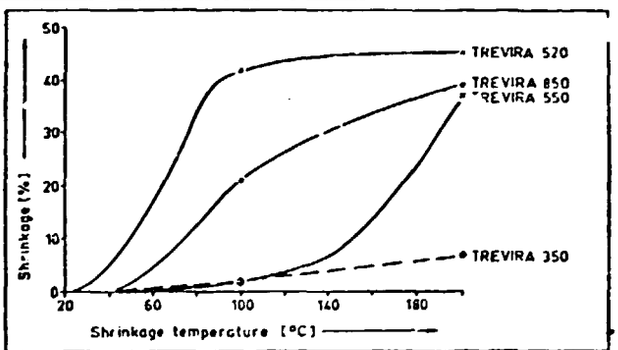
This type shrinks by about 50 % under a shock-like heat treatment, for example with boiling water, steam at 130° C or hot air at 200° C. However, it was soon found that TREVIRA 520 is rather unsuitable for the garment field. On the other hand,

the fibre has proved successful for years in the industrial field. It is converted, alone or mixed with other TREVIRA fibres, into non-woven fabrics and felts, from which synthetic leather and industrial filters are manufactured.

Thus a physically modified fibre did not achieve the objective of imparting greater volume to a weaving yarn or knitting yarn.

This objective appeared to be met only by chemical modification of the polyethylene terephthalate. Our development work resulted in the high-shrinkage fibres TREVIRA 550 and TREVIRA 850, and in accordance with their specific shrinkage properties the former is particularly suitable for the weaving sector and the latter for the carpet industry. Again TREVIRA 550 was to much a speciality for the European market, so its production has to be cancelled last year.

I would like to explain the shrinkage behaviour of these fibres in more detail with the aid of the shrinkage diagrams (Figure 9).




Shrinkage of various TREVIRA fibres in boiling water, and subsequently in hot air at 200°C — ATA-T 606

In the process of conversion from the staple fibre to the finished article, a fibre is essentially exposed to a decisive heat treatment on two occasions:

1. During dyeing, which takes place in an aqueous medium from 98° C to 125° C;

2. During finishing, through the setting process at 185° C to 195° C.

The shrinkage curves in Figure 9 were obtained under these conditions. The fibres were first brought into boiling water

and then exposed to hot air. TREVIRA 350, a normal-shrinking fibre, was used for comparison.

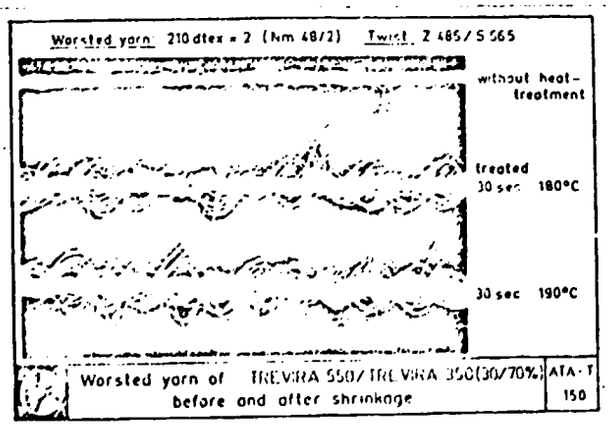
As you can see, TREVIRA 550 shrinks only about 2 % in boiling water. Hence the fibre can be dyed as flock, top or yarn, without a significant loss in shrinkage capacity. Only on setting the coloured fabric at 185 to 195° C the full shrinkage of the fibre is released. A bulky material is obtained. Accordingly, type 550 was suitable for use in weaving.

In the case of the physically modified type 520, only piece-dyeing was possible because of the high-shrinkage in boiling water.

TREVIRA 850 shrinks about 20 % to 25 % in boiling water. A hank containing TREVIRA 850 will therefore already shrink during the dyeing process as it is usually wanted in the carpet industry.

Our experiments have shown that the optimum part of high-shrinkage fibres is 30 % in a weaving yarn and 40 % in a knitting yarn. For carpet yarns the amount of high-shrinkage fibres in the yarn is 40 to 60 % depending on the volume one wants to obtain.

The next slide (Figure 10) shows a blended yarn which can be used for weaving. It consists of 30 % TREVIRA 550 and 70 % of TREVIRA 350.




The effect of heat (180° C or 190° C) is that the high-shrinkage component contracts. So the yarn becomes shorter and bulkier, the fabric more voluminous.

To finish the "low denier" textile part of our polyester survey let me show you with the next slide (Figure 11) the unlimited possibilities of application of TREVIRA fibres.

| COMPONENTS | PERCENTAGE % | AREAS OF APPLICATION |
|---|---|---|
| PES/Cellulosics | 50/50, 65/35, (67/33), 70/30 | Dresses, slacks, underwear, nightwear, shirts, light overcoats, sportswear, labour wear, bedding |
| PES/Wool | 55/45, 70/30 | Costumes, home furnishing, trousers, apparel, coats, pullovers, uniforms |
| PES/Linen | 65/35, 80/20 | Outerwear, home furnishing, table cloth |
| PES/Silk | 70/30, 85/15 | High quality outerwear |
| PES/PAC | 50/50, 60/40 65/35, 70/30 | Ladie's and children's clothing, pullovers, home furnishings |
| All mixtures | 30/40 HS | High volume fabrics (woven and knitted) |

PREFERRED MIXTURES OF POLYESTER FIBRES — ATA-T 643

Beside the 100 % use the main applications are in blend with various other fibres. I think, especially this possibility of blending and also the simple possibility of fibre-modification has made the polyester fibres to the greatest synthetic fibre and - as well - to the most versatile fibre.

Now let us turn our interest to carpet fibres.
Our range of types includes four types for supplying the carpet industry, namely the standard type TREVIRA 820, of circular cross-section, the trilobal profiled fibre TREVIRA 823, and the chemically modified types TREVIRA 810 and 850. The fibres are supplied in gauges of 8.9 and 17 dtex.

80 % are spun as semi-worsted yarns (Mackie yarns of 150 mm staple) and only 20 % are spun as carded yarns of 100 mm staple length. The yarns are further converted either by weaving or tufting especially into shags, bathroom carpets, tip shear carpets, crimped velours and short-pile velours. Polyester is especially preferred in these areas because of its good heat setting properties. The pile weight is between 800 g/m$^2$ (bathroom carpets) and 1600 g/m$^2$ (shags).

Blending with 20 % of TREVIRA 823, the trilobal profile type, imparts a specific gloss, for example to the crimped velour. Especially in the USA the profile type ist also used in 100 %, there a pentalobal type is favoured.

TREVIRA 810 is a newly developed carpet fibre in the Hoechst program. It gives the carpet a better crease resistance, a better abrasion durability and particularly a very good dyestuff affinity. So carpets from this material can be dyed continuously at 100° C without any carrier. In blends with the standard type TREVIRA 820 it can also be used as a deep dyeing component and multicolor effects can be achieved in a single-bath process, e.g. with acrylics.

The fourth carpet type, TREVIRA 850, is a high-shrinkage type. Its application has already been mentioned before.

Our experiments have shown that this type can be spun with TREVIRA 820 to give a high bulk yarn. This is used for the manufacture of shags. By virtue of the high-shrinkage component, the pile weight can be kept about 25 % lower for the same covering power. Furthermore, special bouclé effects can be produced with this carpet fibre.

The last TREVIRA fibre I would like to mention is type 860, which is used as a filling fibre for anoraks, quilts, sleeping-bags, cushions and the like. It has a circular cross-section and a special antisticking preparation. This prevents intimate enmeshing of the individual fibres in the fleece. These fleeces show therefore a very good retention of their initial thickness and do not felt. Quilted goods made from TREVIRA 860 can therefore be washed without any special precautions.

## 2. TREVIRA CONTINUOUS FILAMENTS

After having considered the polyester staple fibres, I would now like to give you a similar survey of TREVIRA continuous filaments and their fields of application in textiles.

You undoubtedly know that the production of polyester continuous filaments has shown unusually high rates of increase, and that almost the half of the polyester textile market is already conquered by the polyester filaments. Though it is a

relatively compact group of applications, in which continuous filaments have been able to achieve great market importance, the individual textile fields, such as for example women's outer wear, mostly demand a large number of varieties of yarn. A particularly broad range of types is therefore necessary if all wishes as weight per unit area, gloss, handle, pattern and appearance of the finished article are to be fulfilled.

In the next slide (Figure 12) I have arranged the various

| Total denier | Number of filaments | Type: flat | Type: textured | Main fields of application: Weaving | Main fields of application: Knitting |
|---|---|---|---|---|---|
| 30 | 15 | x | | Blouses (chiffon) dresses (paisley) | |
| 50 | 15 | x | x | Dresses, blouses (shirt cloth) | |
| | 20 | x | | Linings, mini and evening dresses | Velours, curtains |
| 76 | 24 | x | x | Blouses dresses, ties linings, voile | |
| | 32 | x | | | Swimwear, outerwear light jerseys, curtains |
| 84 | 16 | x | | | Velours |
| 100 | 40 | x | | Drapery, dresses, blouses (georgette) overcoats curtains, ties | Curtains |
| 110 | 20 | | x | Dresses, linings | |
| | 32 | | x | | |
| 150 | 48 | x | x | Ties dresses | |
| | 64 | x | | Drapery | Outerwear, swimwear |
| 167 | 32 | | x | Dresses, costumes, men's wear | |
| 200 | 64 | | x | | Pullovers |
| | 96 | x | | Curtains | Curtains |
| 250 | 48 | | x | Dresses | |
| | | x | | Leisure wear, children's wear | |

Application of TREVIRA filamentyarn — ATA-T 645

TREVIRA filament types in sequence of increasing total gauge. In order to keep this summary as compact as possible, I have had to cut listing the matting, the filament cross-section and the yarn twist as well as special melange yarns. Here, too, you can get spundyed black versions.

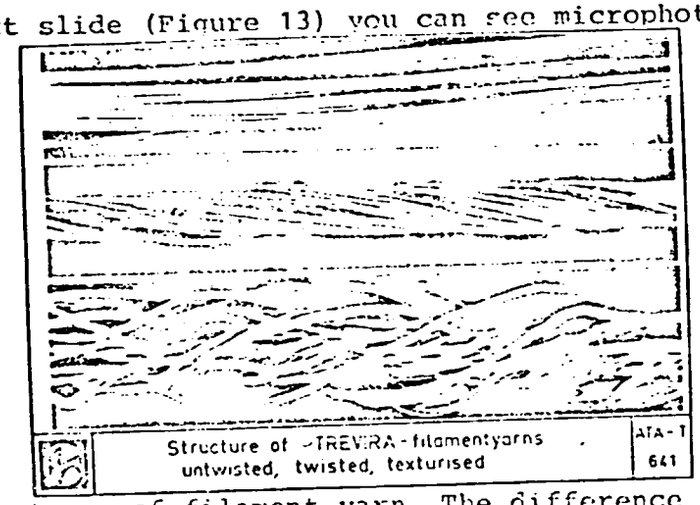
As you can see, we supply, to the various textile fields, TREVIRA continuous filaments of total gauges between 30 dtex and 250 dtex. Their choice depends on the article to be produced, on its weight per unit area and on how the goods are to turn out.

The individual gauge, that is to say the fineness of the individual single filament, is 2 to 6 dtex depending on the end use. It affects the handle of a woven fabric or knitted fabric so that it can range from "flowing and smooth" to "grainy and hard".

Our TREVIRA filaments are spun from bright, semi-dull or dull raw material by melt spinning. Their cross-section can be circular or pentalobal.

For textile usage, the TREVIRA filaments are either given a particular twist, varying from 300 to 1500 turns per metre, or the filaments are entangled by a special process using compressed air, where-by the bond between strands is kept together better, or the filaments are texturised, the choice depending on the end use.

In the next slide (Figure 13) you can see microphotographs of



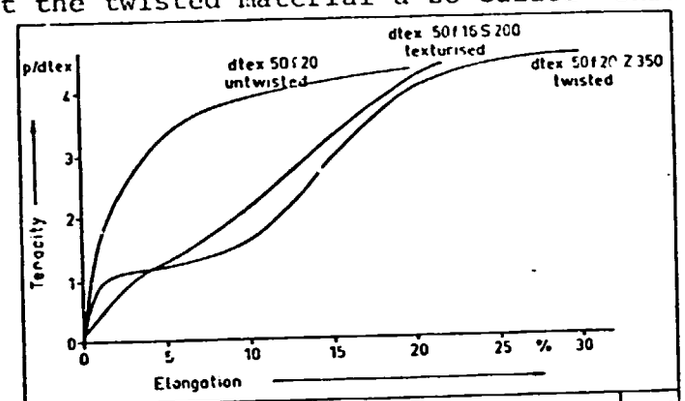

these three types of filament yarn. The difference in bulkiness can clearly be seen.

At present, about 80 % of the polyester filaments which we manufacture are texturised, as well the false twist process as draw texturising being used. The latter brings a simplification of the production, because heat setting is done in a one step process at the texturising machine.

I would like to consider the question of why polyester continuous filaments have been able to attain such great market importance. This can only be partially explained by the scope for varying individual gauges, total gauges, cross-section, matting, yarn twists and the like, to which I have already referred. It is above all the physical properties of the polyester raw material which must be viewed as the reason for this success, particularly the possibility of heat-setting the polyester filaments which ultimately causes the good dimensional stability and good crease resistence of the finished articles.

We consider that the relatively steep slope of the load-elongation curve (Figure 14) in the lower region is a further ad-

vantage of untwisted polyester continuous filaments. The further behaviour of the filaments depends on their thermal history. So you find at the twisted material a so called "shrinkage saddle".




Load elongation curves of ®TREVIRA filaments — ATA-T 650

The filament possesses high strength even at low elongation and hence brings good wear properties. Woven or knitted goods made from polyester contiruous filaments can be washed very easily and dry rapidly.

Their tendency to abrasion is slight. Additionally, an important factor in the use of continuous filaments in furnishing textiles and decorative fabrics is the good light stability of the polyester. Finally, the molecular structure of the polyester makes it possible to obtain very lightfast dyeings.

I would next like to deal in somewhat greater detail with the various textile uses of TREVIRA continuous filaments. As you see in the next picture (Figure 15), I have chosen to do this through a division according to the technologies used to manufacture the finished articles.

| TECHNOLOGY | MAIN FIELDS OF APPLICATION |
|---|---|
| Warpknitting | Curtains, velours (draperies, upholstery for home and automotive uses, leisure wear) outerwear, (light print cloth, dresses) |
| Flat weftknitting and flat knitting | pullovers, knitted jackets, fully-fashioned articles |
| Circular knitting | Women's outerwear (blouses, dresses, costumes, coats) men's outerwear (suits, trousers, jackets) swimwear |
| Weaving | Women's outerwear (blouses, dresses, costumes, coats) men's outerwear, curtains, draperies, ties, linings |

USE OF ®TREVIRA FILAMENTYARN — ATA-T 642

Basically, polyester continuous filaments are converted either into knitted goods or into woven goods. These two groups of articles are based on the technologies of knitting and weaving respectively.

One of the main areas of application of the filaments is the warp knitting. Within this technology the biggest area are curtains. In West Germany, at the present time, over 85 % of all curtaining fabrics are knitted on Raschel machines. For this purpose, mainly fine gauges of between 50 an 76 dtex of semi-dull or dull raw material are employed. The advantages of polyester curtaining, namely high light resistance, low soiling and easy-care, have given this article an absolutely dominant position on the market.

Polyester filaments are also manufactured on warp knitting machines to velours and velvets. These knitted velours are produced from smooth filaments with gauges of 50, 76 and 84 dtex. Very hardwearing and attractive articles result, which can be used as draperies as upholstery for home and automative uses and for leisure wear.

Outer garment fabrics can also be produced on warp knitting machines and on Raschel maschines. Here, mainly texturised polyester filaments are used, partly combined either with smooth filaments or with spun fibre yarns. The resulting articles range from lightweight print cloth, blouse fabrics and dress fabrics, to men's trousers.

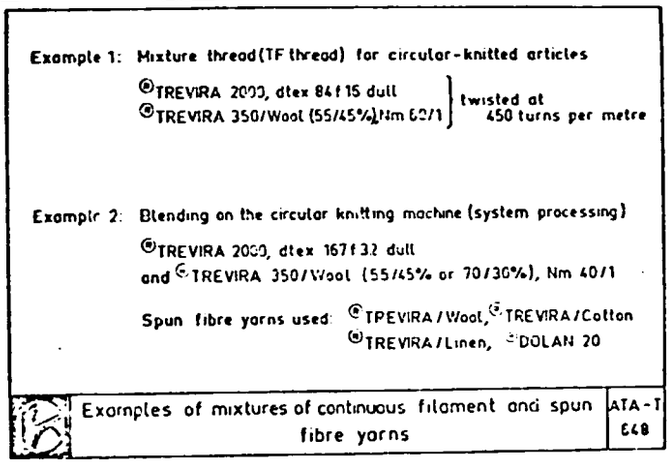
Flat weft knitting machines or cotton machines and flat knitting machines predominantly employ bright, profiled texturised filaments, which are largely yarn-dyed. The most commonly used continuous filaments are in gauges of 110, 150 or 200 dtex.

The pullovers produced on cotton machines are distinguished by clear meshes, low weight and an elegant, silky appearance, while articles produced on flat knitting machines have heavily structured patterns.

The most important application of TREVIRA filaments is undoubtedly the circular knitting field. The diversity of patterns

which are possible on circular knitting machines, and the extraordinarily economical and uncomplicated manufacturing process, have allowed this field to become the dominant field of use for texturised filaments. Articles manufactured on these machines have excellent wear characteristics and easy-care properties.

In recent times the trend in the knitting area is clearly going towards spun yarns. So mixtures of texturised continuous filaments and spun yarns are being used to an increasing extent. There are two possible combinations (Figure 16):




A mixture thread of a texturised continuous filament, for example TREVIRA 2000, and a spun yarn, for example TREVIRA 350/wool, is produced on a ring spinning machine. Because of the high price this method didn't get too much acceptance. We prefer the direct combination of the continuous filament yarn and the spun yarn on the circular knitting machine by different feeding of the knitting systems.

TREVIRA/wool, TREVIRA/cotton, TREVIRA/linen or DOLAN®, our acrylic fibre, can be employed as spun yarns. If DOLAN is used as the staple fibre component, two-colour effects can be obtained with single-bath piece dyeing.

The fabrics produced on circular knitting machines are preferentially used in the outer garments field. There are particularly knitted suits for men, which got a really good start in the USA for leisure wear and career apparel.

Furthermore texturised highly elastic polyester filaments of gauge dtex 76 f 24 are used in swimwear because of their good dimensional stability in wet conditions

The fourth technology which remains is weaving.

Numerous articles with very diverse properties can be manufactured from TREVIRA filaments on looms. Hence this field demands an unusually wide range of gauges. It extends from the finest to the coarsest gauge, in the various degrees of matting and twist; it includes smooth and texturised yarns and finally also various cross-sectional shapes of tne individual filaments.

By far the biggest field within silk weaving is the women's outer garment field. Here, again, spun yarns are increasingly used as well as effect yarns, like slub yarns and flake yarns. The articles which result range from the finest silk fabrics for blouses to heavy coat fabrics.

The particular properties of continuous filaments have resulted in over 80 % of tie fabrics in West Germany being woven from this material. Smooth or texturised filaments are used as well for the warp as for the weft. The gauges are between 50 dtex and 150 dtex.

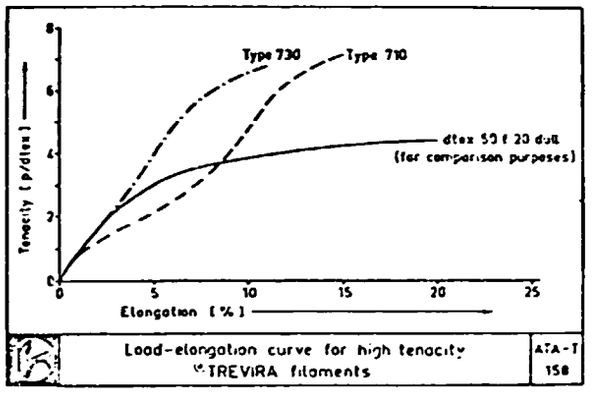
In addition to the washability for the ties TREVIRA is particularly used because of its good crease resistance, the brillant colours and the silk like hand.

The constantly increasing acceptance of easy-care clothing demands a corresponding development of lining fabrics which are comparable to the outer fabric in these particular properties. For lining fabrics, we recommend smooth filaments in the warp and texturised filaments with pentalobal cross-section in the weft. TREVIRA lining fabrics have very little tendency to crease, and possess high dimensional stability, low moisture absorption and good moisture transmission. The weights per unit are up to 30 % less than those of viscose lining fabrics. At the moment it's only the higher price that prevents further expansion.

## 3. TREVIRA FC . INDUSTRIAL APPLICATIONS

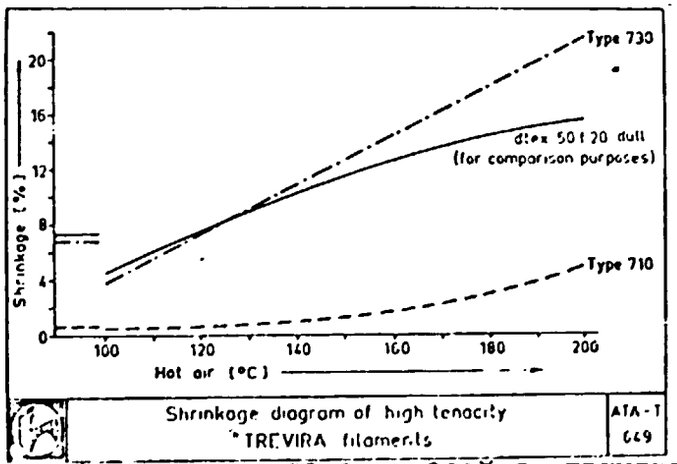
Finally I would like to give you a short survey of the industrial uses of TREVIRA fibres, yarns and monofilaments. I have kept this part of my lecture rather brief since you have an other lecture on this matter.

We call the TREVIRA filaments used in the various industrial fields as "TREVIRA high tenacity". This becomes clear in the following picture. It represents the load-elongation curve of the high tenacity types 710 and 730 in comparison with a continuous filament for textile purposes.




Load-elongation curve for high tenacity TREVIRA filaments — ATA-T 158

The tenacity of those filaments is about 7 p/dtex, corresponding to 90 to 100 kg/mm$^2$. On the other hand, the two TREVIRA types differs fundamentally in their shrinkage behaviour.




Shrinkage diagram of high tenacity TREVIRA filaments — ATA-T 649

TREVIRA 730 shrinks by about 22 % at 200° C, TREVIRA 710 only about 5 %. As you will see this low shrinkage has great advantages for a series of applications.

| Type | Characteristics | Main fields of application |
|---|---|---|
| 710 | Low shrinkage | Woven fabrics for coating and rubber covering, primary backing for carpets, hoses, ribbons for wash and wear articles |
| 712 | Low shrinkage | Sewing threads |
| 715 | Low shrinkage – rubber receptive finish | Cords for V-belts and conveyor belts, fabrics for coating, high pressure hoses |
| 730 | Normal shrinkage | Safety belts, straps for dragging and loading, sailcloths, cables, ropes, nets, shrinking strips for the electrical industry |
| 732 | Normal shrinkage | Sewing threads |

®TREVIRA multifilaments for technical applications — ATA-T 644

In the next slide you see the main fields of application of "high tenacity" TREVIRA. Beside the standard types 730 and 710 you see some types for special purposes like the sewing thread-types 712 and 733 and the special type for U-belts and conveyor belts, TREVIRA 715. TREVIRA 710 as well as 715 are mainly used in the coating industry and the rubber industry. Because of their low shrinkage, it is possible to coat the finished fabrics with polyvinyl chloride, or with rubber, without subjecting them to a prior heat-setting process. Thus the processor is saved one finishing process.

TREVIRA 710 is furthermore used for the manufacture of primary backings for the tufting-industry - called TREVIRA TTT. The warp of these fabrics consists of filaments of 280 dtex and the weft of 1100 dtex. The fabric is provided with a non-slip finish and weights only 130 g/m$^2$. It is particularly suitable for tufting, and gives a uniform product. The low-shrinkage TREVIRA filaments ensure that coating presents no problems. The finished carpets are dimensionally highly stable both dry and wet, so that they can be used as "indoor and outdoor carpets".

Safety belts can be produced from grey TREVIRA filaments or from spun-dyed black material.

In recent years, synthetic monofilaments have gained increasing importance in the industrial field. In comparison to polyethylene, polypropylene and polyamide monofilaments, the polyester monofilament possesses certain advantageous properties which are not obtainable by the other materials.

Our polyester monofilaments are marketed under the name "TREVIRA monofil". Here again we offer a broad range of types for various applications. They differ in their elongation and their shrinkage, depending on the end use. The diameter of the monofilaments is between 0,03 and 2 mm.

There are above all two main fields of use to which I would like to refer:
On the one hand the monofilaments are converted into zip fasteners. They are used in fine versions in the garment field and as high strength zipfasteners in tents. The second large industrial field of use is the sieve field. Because of their high abrasion resistance, flexural stiffness and dimensional stability, sieves of TREVIRA monofilament are in special demand by the paper industry. They are used in the dry and wet parts of the papermaking machines and are very much better in effectiveness of use than metal sieves.

Woven fabrics of TREVIRA monofilament are furthermore used for sieving flour, as chemical filters, as screens for screen printing etc.

TREVIRA spun fibres are also employed in the industrial field. I have already mentioned that our high-shrinkage fibre TREVIRA 520 is used to manufacture fleeces for synthetic leather and felts for filtration purposses. It is used either by itself or mixed with other TREVIRA fibres, for example with types 120 and 220.

At the end of my lecture I would like to show you some pictures which are intended to demonstrate the diversity of possible uses of coated fabrics made of high tenacity polyester filaments:

Slide 20: A large air supported hall, about 70 m long, used as a warehouse;
Slide 21: The german pavillon at Expo 1970 in Osaka;
Slide 22: Big containers for agricultural industry;
Slide 23: A truck covered with a TREVIRA tarpaulin
Slide 24: A big sporting device from TREVIRA high tenacity which is used for example for the training of cripples.
Slide 25: A model of the developing project "shadow in the desert".

HOECHST AG started the production of TREVIRA fibres in 1955, that is to say only 20 years ago. As you have seen, a broad range of types for a variety of special applications in the meantime has been developed. Yet there is no end in research and development. Targets as flame retardant or selfextinguishing fibres, filaments with a spun yarn touch or technical filaments with high lightfastness are to be reached. We are working intensivly on those problems.

I am sure that before long we shall be able to report on new types of TREVIRA which will mean simplifications to the user and improvements to the consumer.