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POLYPROPYLENE COMPOSITE FIBRES, SPINNING, STRUCTURE AND PROPERTIES

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The paper deals with polymer composite fibres, spinning, structure and properties. In the introduction part, a review of polymer composites based on nanofillers with a high aspect ratio, such as layered silicates and carbon nanotubes, is given. In the second part, the experimental results concerning the spinning of polypropylene/boehmite and polypropylene/carbon nanotubes composite fibres, their structure and selected mechanical properties are presented. The material composition and processing conditions leading to the enhanced mechanical properties of composite fibres are discussed in the paper as well.

1. Introduction

Inorganic fillers are very often used for improving the desirable properties of polymers. Many of them such as calcium carbonate, titanium dioxide, talc, glass beads and short glass fibres have been used intensively to enhance the mechanical properties of polymers [1, 2]. Fillers with a larger aspect ratio such as short fibres were found to be more effective modifiers. A similar effect was expected when an inorganic filler with dimensions on a nanometer scale and a high aspect ratio such as layered silicates (LS) and carbon nanotubes (CNT) was used for forming polymer composites. The aspect ratio of the layered silicates is about 200; for CNT this is substantially higher (more than 1000), [3].

The incorporation of layered silicates in polymers and forming a dispersion with separated nanoparticles to prepare polymer nanocomposites is crucial in the development of new polymer composite materials. Mostly polyolefin nanocomposites with an exfoliated structure require the treatment of a filler with organic compounds and additionally use special compatibilisers [4].

One of the most commonly used organically layered silicates is derived from montmorillonite (MMT). This is formed by stacked layers with a layer thickness of around 0.96 nm and a lateral dimension of 100-200 nm. The layers form stacks with an interlayer between them. An individual layer with an interlayer represents the repeat unit of a multilayer material called d-spacing or basal spacing (d001) and can be calculated from the 001 plane obtained from X-ray diffraction patterns [5].

The hydrophilic nature of layered silicates which is not favourable for dispersion in organic polymers can be suppressed and altered to be more hydrophobic by, e.g., ion exchange reactions with cationic surfactants, including primary, secondary, tertiary and quarternary alkylammonium cations [6]. Organically treated layered silicates are organoclays suitable for preparation of polymer nanocomposites with polar functional groups such as polyester (PES) and polyamide (PA). For polyolefin nanocomposites such as polypropylene (PP) and polyethylene (PE), it is also necessary to use a convenient compatibiliser such as maleic anhydride modified polypropylene [7].

There are two important factors necessary to achieve the exfoliation of layered silicates. The compatibiliser should be miscible with a PP matrix and include suitable polar groups in the molecule. Regarding the structure of the layered silicates in a polymer matrix, the composites can be classified as intercalated or exfoliated nanocomposites. The fully exfoliated structure of silicates in polymers is rare. The combination of intercalated and exfoliated structures in polymer nanocomposites represents actual polymer nanocomposites [8].

The intercalation and exfoliation of clay platelets in polymer melt depends on the thermal diffusion of polymer chains (or a compatibiliser) in the interlayer space and on shear stress during mixing. Uniform dispersion with a high share of clay nanoparticles in the polymer matrix enhances the Young's modulus and tensile strength but significantly reduces the tensile ductility and impact strength compared to a neat polymer.

At this time, there are several producers of organoclays available commercially such as Souther Clay Products, USA (Cloisite® 10A, 15A, 20A and 30B); Süd Chemie, Germany (Nanofil® 2, 5, 9, SE300, SE3010); Elementis Specialties Company (Bentone® 107, 108, 109 and 2010); Nanocor Inc, USA (Nanomer® 1.30P, 3.31PS, 1.44P, 1.44PT, 1.28E); Laviose Chimica Mineraria, Italy (Dellite 72T); Co-op Chemicals, Japan (Somasif® ME100).

The dispersion of CNT in polymers is relatively poor compared with lower aspect ratio particles due to the nanotubes having a strong tendency to agglomerate as a result of their high surface areas and fibrous nature. Their very stable chemical characteristics and lack of functional sites on the surface also complicate the dispersion issue. The length of CNT, which can range up to several millimeters, is the most undesirable for practical application [9]. Both physical and chemical approaches have been adapted to reduce the length of CNT to certain extents that are suitable for blending. These methods also activate the CNT at the open-ends via the formation of functional groups. The physical dispersion route includes ultrasonication, ball milling grinding and high speed shearing [10, 11]. Chemical treatment with sulphuric/hydrochloride acid and nitric acid in combination with laser treatment enables the successful conversion of the CNT from being nearly endless and highly tangled into short and open-ended pipes. Besides, a similar method provides functionalised CNT, e.g., by carboxylic or $-NH_2$ groups [12]. Reactive functional groups are given an opportunity to prepare CNT functionalised with other polymer containing -OH groups such as polyvinyl alcohol (PVA) via an esterification reaction. The PVA/CNT films and fibres were prepared in this way [13, 14].

The preparation of aligned polymer/CNT bulk composites remains a scientific challenge for material scientists. Enhanced mechanical and physical properties can be further achieved in polymer/CNT composites provided that the CNT are well aligned within the polymer matrix. One approach for preparing aligned polymer/CNT composites utilises penetration of a monomer in a liquid or gas form in to the CNT bundle following in situ polymerisation. The PE/CNT, polyaniline/CNT, PMMA/CNT composites were prepared in this way [15].

The tendency of CNT to form agglomerates could be minimised by the appropriate application of shear forces. Nanocomposites based on PE, PP, PC and PMMA with a uniform distribution of CNT particles in a polymer matrix were prepared by the optimisation of the shear mixing of the blends [16].

Many producers of CNT all over the world offer various kinds of un-functionalised and functionalised products such as Nanocyl S.A. (Belgium), NanoLedge Co. (France), Nanothinx Co. (Greece), SouthWest NanoTechnologies Inc. (USA), Carbon Nanotechnologies Co. (USA), Carbon Nanotech Research Institute Co. (Japan), ILJIN Nanotech (Korea), and Shenzhen Nanotech Port Co. (Chinese).

Polymer nanocomposite fibres

Oriented polymer composites such as composite fibres represent a special group of polymer materials. The mechanical properties of fibres depend on their molecular and supermolecular structures and the orientation of their crystalline and amorphous regions. Some papers have shown enhanced mechanical properties of polymer composite fibres, such as tenacity, Young's modulus, ductility, and stiffness; and further, the improvement of electrical conductivity, un-flammability, dyeability and other properties. Deformation and orientation of the structural elements of polymer nanocomposites upon spinning and drawing have been shown as crucial from the point of view of the final properties of composite fibres.

In the next part a short review of selected polymer composite fibres is presented [17-30]: Polyethylene terephthalate (PET)/organoclay nanocomposite monofilaments were prepared by in situ interlayer polymerisation and spinning with various draw ratios (DR=1-16) in the spinning line. The dodecyl triphenyl phosphonium ion for an ion exchange reaction with MMT to improve exfoliation because of the degradation of the common quarternary ammonium compounds at a processing temperature (280°C) was used. A high degree of exfoliation of the organoclay was obtained in this way. The mechanical properties of the spun filaments correlated with the organoclay concentration and draw ratio upon spinning. The tensile strength and initial modulus as well as the thermal stability of the composites increased with the organoclay concentration and decreased with the higher draw ratio. The supermolecular structure of the polymer matrix did not change clearly dependingon the filler concentration [17]. Similar results were obtained for polybuthylene terephthalate (PBT) and polytrimethylene terephthalate (PTT) fibres [18].

Other nanofillers such as SiO_2 and carbon nanotubes (CNT) were used for the preparation of polyester composites. The effect of the deformation of polybuthylene terephthalate/polytetra methylene oxide

(PTMO) containing 0.2 wt% of the single walled CNT (SWCNT) on the mechanical properties in the elastic region was observed. The higher rigidity of the nanocomposites led to increases of Young's modulus and the yield strength of the drawn samples [19].

The effect of the MMT on the supermolecular structure and the mechanical and thermal properties of the polyamide 6 (PA6) composite fibres at a temperature above the glass transition was studied [20]. The organoclay platelets have a nucleating effect on the polyamide matrix and contribute to the reinforcement of the nanocomposites building up a rigid percolation network together with the crystalline lamellae. The prepared fibres, exhibited improved stiffness and tensile strength as a result of the enhanced drawability [21]. The organoclays strongly affect the mainly crystalline structure of the PA6 fibres depending on the drawing and annealing temperatures as well as the draw ratio.

The high level of exfoliation of the organoclay (Cloisite 30B) in the PA6 permitted use of electrospinning technology for preparation of the composite nanofibres. Dispersion and exfoliation of the organoclay in PA6 were achieved by melt-extrusion in a twin-screw extruder prior to dissolving it in an aqueous formic acid. The platelets of MMT were oriented along the fibre's direction. The structure and mechanical properties of PA6 composite nanofibres depend on the MMT concentration and fibre diameter. Fibres with a smaller diameter (80 nm) exhibited a two times higher Young's modulus compared with conventional PA6 composite fibres. The ultimate strength of the nanocomposite fibrous mats was decreased compared with the unmodified materials due to their larger fibre size diameter [22]. The organoclay modified polyamide fibres also exhibited besides their improved mechanical properties a higher dyeing ability [23] and lower flammability [24].

The PA6/MWCNT and PA6/carbon nanofibres composites were prepared using a twin-screw microextruder, and the resulting blends were spun to produce a series of reinforced polymer nanocomposite fibres. A high degree of nanofiller dispersion in the PA6 matrix was achieved, and significant improvements in stiffness were observed using the aligned CNT. A higher modulus and stiffness for the PA6/MWCNT fibres, compared to the PA6/carbon nanofibres, were obtained [25].

MWCNT were used for reinforcing the ultra high molecular weight polyethylene (UHMWPE) fibres. The composite fibres were prepared by gel-spun technology. By adding 5.0 wt% MWCNT, ultra strong fibres with a tensile strength of 4.2 GPa and strain at break of about 5%, were produced. The tensile modulus and strength were about 15 - 20% higher in comparison with the unmodified fibres. The composite fibres appear to show very good concordance with the predictions of the mixtures rule [26].

The extrusion/drawing process was used for the preparation of the polyacrylonitrile (PAN)/MWCNT composite fibres. The higher deformability of the nanocomposite filaments resulted in a two-fold higher draw ratio, which supports the higher crystalline and morphological orientation as well as an axially oriented array of nanotubes compared with the unfilled sample. The composite fibres exhibit other crystalline structures and new, lower mechanical properties, but a higher electrical conductivity [27].

Polypropylene composite fibres

Recently, several papers described the spinning of polypropylene composite fibres containing organoclay, carbon nanofibres and CNT. Commercial organoclays, such as Somasif ME100 and Nanofil 15, were examined. The PP/organoclay composites with various contents of compatibilisers based on PP grafted by maleic anhydride (PP-g-MA), were prepared using a twin-screw extruder. The high exfoliation level of the MMT layers was confirmed using a TEM analysis. The basic tensile properties, tenacity and Young's modulus were investigated depending on the draw ratio in the drawing process. Only a slightly higher tenacity and modulus of composite fibres at the maximal draw ratio were obtained. Besides, a decreased drawability of the composite fibres was found [28-30].

In order to obtain the high exfoliation effect of MMT in a PP matrix, organically treated silicates and a compatibiliser, e.g., PP-g-MA in a higher amount of up to 10%, must be used [4, 7, 28, 30]. Besides, the drawing and orientation of the composites are very significant regarding their mechanical properties. From this point of view research concerning the deformation, orientation and tensile properties of oriented polymer composites are very important [31, 32].

The high tenacity and high modulus PP/carbon nanofibre nanocomposite fibres were prepared by Chatterje and Deopura. They used a special drawing method based on several stages of drawing with a three heaters temperature gradient. The final drawing temperature was within 130 - 160°C and a drawn speed of 1m/min. The nanocomposite fibres exhibited a higher orientation of the structural elements and a lower crystallinity, which resulted in a higher tensile strength (770 MPa) and modulus

(16.8 GPa) compared to 670 MPa and 16.4 GPa for the neat PP fibres [33].

2. Experimental

In our contribution, the spinning of polypropylene/organoclay and polypropylene/carbon nanotube composite fibres and the effect of orientation on their mechanical properties are presented. A laboratory twin-screw extruder, Φ=28 mm, was used for preparation of the PP composites before spinning. The composite fibres were prepared using a laboratory spinning line with an extruder of Φ=16. The multifilaments were drawn for various drawing ratios. The mechanical properties of the PP composite fibres depending on the the spinning and drawing conditions were evaluated. The effect of the compatibilisers-dispersants on the non-uniformity and mechanical properties of the fibres, resulting from the processing of the PP composites in spinning and drawing, was estimated. The factors leading to the PP composite fibres with an enhanced tenacity and Young's modulus are discussed in the paper, as well.

The following polymers and materials were used in our experimental research: Polypropylene (PP): PP TG 920 (PP TG), MFR 10.5 g/600s, Slovnaft Co., SK; PP Moplen 500R (PP M500R), flakes, MFR 25 g/600 s and PP Moplen HP561N (PP M561N), MFR 11 g/600 s, all produced by Basell, Italy. The commercial organoclay based on montmorillonite (MMT) used in this work was Cloisite 15A (C15A), which is produced by Southern Clay Product, USA, and Boehmite Disperal type (B40), produced by Sasol Co., Germany as well as Multi-Wall Carbon Nanotubes - Nanocyl® 7000 (MWCNT), produced by Nanocyl S.A., Belgium. Surfactants based on polypropylene glycol (S44P) and alkyl-polysiloxane (TEG) were used as compatibilisers-dispersants.

The coefficients of the variation of the fibre diameter CV_d and basic mechanical properties, tensile strength (CV_T), elongation at break (CV_E) and Young's modulus (CV_{YM}) were evaluated and used for estimation of the structural and geometrical non-uniformity of the fibres. An Instron (Type 3343) was used for measurements of the tensile strength and elongation at break according to ISO 2062:1993 as well as Young's modulus. The thermal properties were evaluated using a DSC analysis. A Rheovibron DD-II-C, TOYO Baldwin Co., was used for measurement of the dynamic modulus at a temperature range of 20 - 140°C.

3. Results and discussion

Differences between the spinning of the PP/B40 and PP/MWCNT composite fibres were found. Relatively very well dispersed Boehmite in the PP matrix and well spinning up to a concentration of about 5 wt% was in contrast with the PP/MWCNT dispersion with particle agglomerates (bundles) and well spinning only up to 0.2-0.3 wt% of CNT. The non-uniformity of the fibre diameter increased with the higher content of MWCNT in the PP matrix (Table 1). To the contrary, the coefficients of the variation of the mechanical properties do not exhibit any clear changes with the CNT concentration (CV_T and CV_{YM}) nor were they unambiguously decreased (Table 2). This discrepancy was explained when the strong dependences of CV_T and CV_E on the deformation of the fibres were found (Fig. 1).

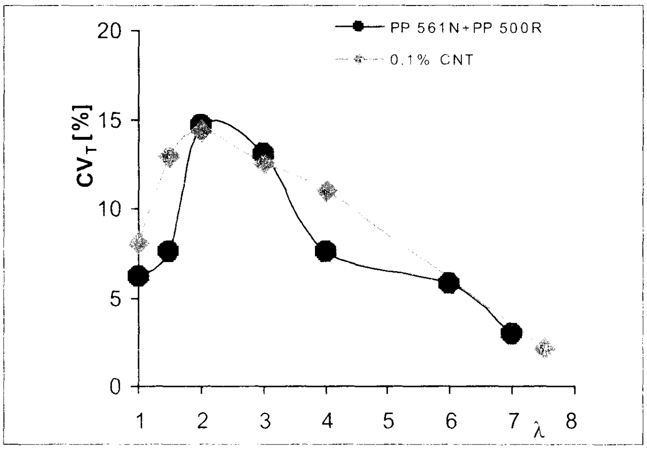
Table 1 The fibre diameter d and coefficient of the variation of diameter CV_d of the PP561N/MWCNT composite drawn fibres (drawn ratio λ=3).

Fibre composition	d [μm]	CV_d [%]
PP standard	19.8	7.7
PP + 0.02% CNT	19.3	14.7
PP + 0.05% CNT	19.8	11.3
PP + 0.1% CNT	19.1	14.8
PP + 0.3% CNT	21.2	10.1

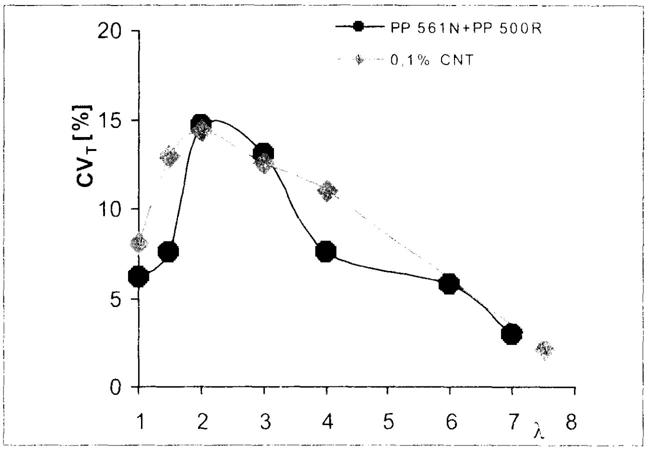
Table 2 The tenacity (T), elongation at break (E) and Young's modulus (YM) and their coefficients of the variation CV for PP561N/CNT composite drawn fibres (prepared using a concentrate containing 1.0 wt% of CNT in PP 500R)

Fibre composition	T [cN/tex]	CV_T [%]	E [%]	CV_E [%]	YM [N/tex]	CV_{YM} [%]
PP standard	43.3	3.4	34.6	22.0	5.4	2.9
PP + 0.02% CNT	38.6	3.1	32.2	20.4	4.9	3.7
PP + 0.05% CNT	33.9	2.4	44.7	11.7	4.5	3.0
PP + 0.1% CNT	33.7	4.8	44.6	12.8	4.5	5.9
PP + 0.3% CNT	30.6	2.9	55.3	5.6	4.2	3.4

The standard spinning and drawing conditions at the spinning of the PP composite fibres did not lead to higher mechanical properties (Table 3). The tenacity of the fibres slightly decreases with the higher concentration of MWCNT in the PP matrix. The dependence of Young's modulus exhibited a slightly maximum for 0.1 wt%.



a.



b.

Fig. 1 Dependence of CV_T (a) and CV_E (b) on the drawing ratio for PP/CNT composite fibres

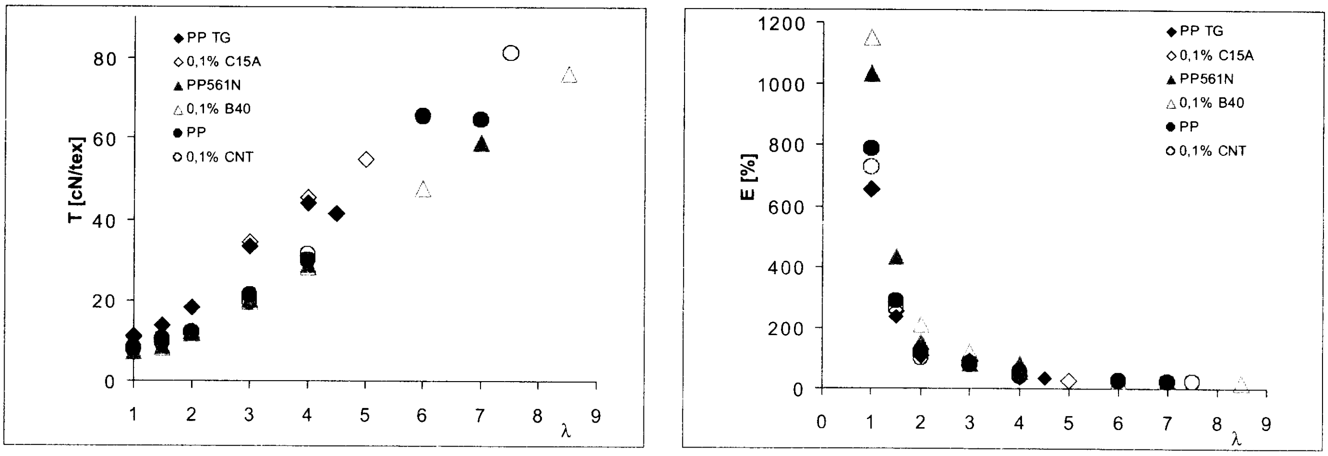
Table 3 The tenacity (T), elongation at break (E) and Young's modulus (YM) of PP TG/MWCNT nanocomposite drawn fibres.

Composition of concentrate	C_{CNT} in fibres [%]	T [cN/tex]	E [%]	YM [N/tex]
PP standard	-	51.6	26.6	4.7
PP 0.3% MWCNT	0.05	48.7	31.6	4.9
	0.1	50.2	29.1	5.1
	0.3	43.2	40.8	4.4
PP 0.3% MWCNT 0.3% TEG	0.05	43.9	33.5	4.6
	0.1	50.3	29.3	5.0
	0.3	42.0	36.1	4.4
PP 0.3% MWCNT 0.3% S 44P	0.05	44.6	37.0	4.6
	0.1	47.4	30.7	4.9
	0.3	45.5	31.6	4.7

Besides, the results in the Table 4 and Fig. 2 showed in the strong effect of the spinning conditions on the basic mechanical properties and supermolecular structure (Table 5) of the composite fibres. Analysis of these results leads to conclusions that higher mechanical properties including the positive effect of nanofillers in a PP matrix can be obtained only with an optimized composition of the composites and spinning conditions. Based on these conclusions, a new series of PP/ and PP/MWCNT fibres were prepared. Higher mechanical properties of the PP composite fibres were achieved, compared to the PP standard fibres, in this case (Tables 6, 7 and Figs. 3 and 4).

Table 4 Effect of spinning conditions on the mechanical properties of PP fibres

No.	Metering [g/min]/ spinning speed [m/min]	T_d [tex] spun f.	λ	T_d [tex] drawn f.	T [cN/tex]	E [%]	YM [N/tex]
1	20/200	97.8	3.5	32.7	29.1	40.1	3.4
2	20/250	80.5	3.2	30.1	26.9	38.6	2.7
3	20/300	54.6	3.0	22.0	30.5	24.2	3.0
4	20/400	43.7	3.2	15.6	45.1	20.0	4.5
5	20/500	34.9	3.2	11.5	61.1	19.8	6.0
6	30/200	126.3	4.0	36.4	30.0	63.6	3.5
7	30/250	120.1	4.0	35.9	31.8	25.7	4.0
8	30/300	89.7	4.0	25.8	42.1	20.4	4.3
9	30/400	68.2	3.8	19.8	42.4	19.6	4.4
10	30/500	49.2	3.5	16.1	49.9	18.5	5.1



a. b.

Fig. 2 The dependence of tenacity (a) and elongation at the break (b) of composite fibres on the draw ratio λ

Table 5 Thermal properties of PP561N/CNT composite fibres depending on the drawing temperature

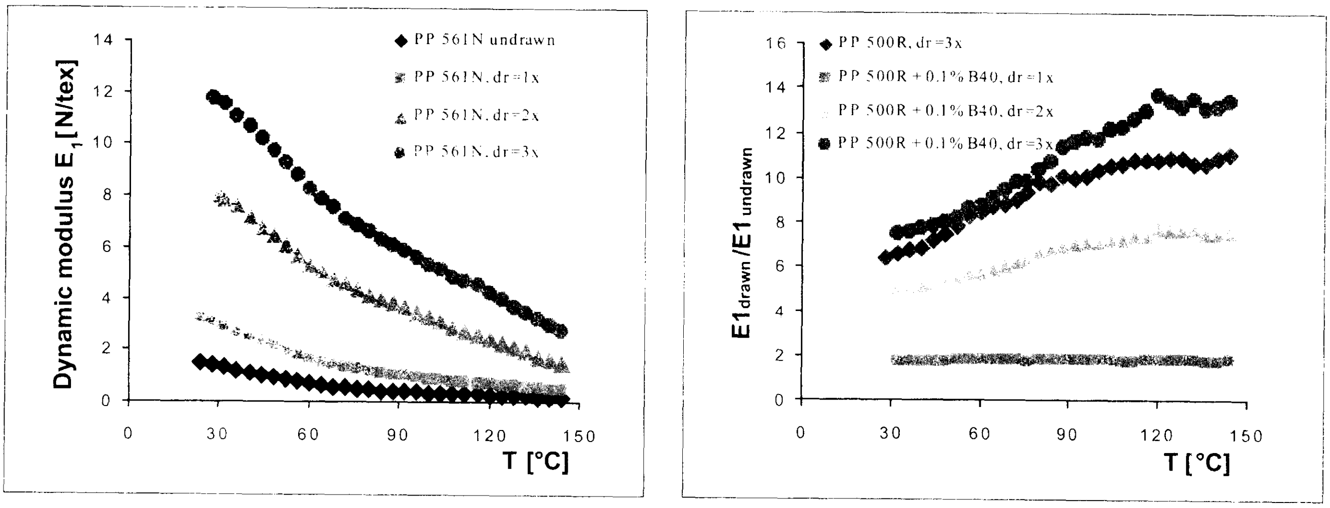
Composition of fibres	drawing T [°C]	1[st] heating		cooling	
		T_{12} [°C]	ΔH [J/g]	T_c [°C]	ΔH [J/g]
PP standard	25	163.5	94.7	113.3	105.7
	50	164.3	103.4	112.8	104.6
	80	165.3	104.3	112.9	103.9
	100	165.1	108.1	112.6	106.3
	120	165.1	112.4	112.6	107.1
	130	165.3	111.7	112.8	105.8
PP 0.1% CNT 0.1% C15A	50	164.1	105.3	121.1	110.1
	80	163.3	103.5	121.1	109.4
	100	165.3	112.1	121.1	112.0
	120	165.3	110.3	121.1	108.9
	130	166.8	114.4	121.1	110.2
PP 0.1% CNT 0.1% C15A S44P	50	163.3	98.9	120.9	108.8
	80	163.8	106.4	120.9	109.7
	100	167.3	106.0	121.1	108.8
	120	165.8	112.9	120.8	110.9
	130	166.8	112.0	120.6	107.3

Table 6 The effect of the composition of concentrates on the mechanical properties of PP561N/Disperal composite drawn fibres, draw ratio λ_{max}

Composition of concentrate	Content of B40 in fibre [%]	T [cN/tex]	CV_T [%]	E [%]	CV_E [%]	YM [N/tex]	CV_{YM} [%]
PP standard	-	59.1	9.4	25.2	8.3	5.7	11.5
PP + B40	0.02	66.9	5.3	20.1	4.1	7.0	5.3
	0.1	65.9	3,7	19.9	5.5	6.9	7.2
	0.3	61.4	3.2	19.1	4.2	7.0	5.6
	0.5	59.9	6.4	26.9	16.4	6.5	9.3
	1.0	56.9	4.6	23.4	14.0	6.0	4.9
	3.0	43.8	5.0	30.5	13.6	4.6	5.7

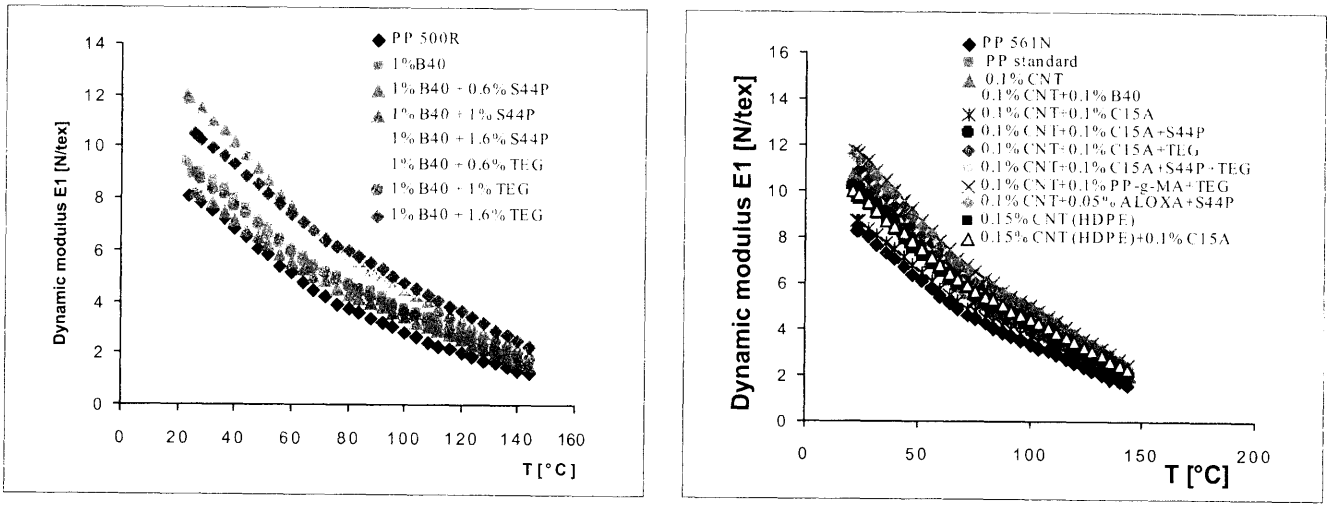
Table 7 Tenacity (T), elongation (E), Young's modulus (YM), and their coefficients of variation for PP 561N/MWCNT drawn composite fibres

Composition of fibres [%]	T [cN/tex]	CV_T [%]	E [%]	CV_E [%]	YM [N/tex]
PP standard	64.8	2.9	22.6	7.6	7.2
PP/CNT	65.1	7.6	22.6	8.1	7.3
PP/CNT + B40	76.1	6.8	20.7	6.9	8.7
PP/CNT + C15A	72.8	5.3	21.6	5.5	7.9
PP/CNT + C15A+ S44P	71.7	8.3	20.3	5.0	8.2
PP/CNT + C15A + TEG	81.2	2.1	21.7	6.2	9.5
PP/CNT + C15A + S44P+ TEG	77.0	2.3	21.7	4.4	9.1
PP/CNT + PP-MA + TEG	76.6	6.2	22.0	9.3	8.9



a. b.

Fig. 3 Dynamic modulus of PP561N (a) and PP/B40 (b) composite fibres depending on the temperature



a. b.

Fig. 4 Dynamic modulus of PP/B40 (a) and PP/MWCNT (b) composite fibres in dependence on temperature

4. Conclusions

The unambiguously positive impact of Boehmite and MWCNT nanofillers on the mechanical properties of the PP composite fibres was found. The PP composite fibres exhibited a higher degree of deformability in the spinning and drawing processes as well as a higher uniformity presented by the coefficients of the variation of tenacity CV_T and elongation CV_E.

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Polypropylénové kompozitné vlákna, zvlákňovanie, štruktúra a vlastnosti

Translation of abstract:

Polypropylene composite fibres, spinning structure and properties

Tento článok je zameraný na štúdium polypropylénových kompozitných vlákien, ich štruktúry a vlastností. Úvodná časť príspevku je venovaná prehľadu polymérnych kompozitov na báze nanoplnív s vysokým pomerom rozmerov, ako sú vrstevnaté silikáty a uhlíkové nanotrubičky. Druhá experimentálna časť práce je zameraná na prípravu a zvlákňovanie polypropylén/Boehmite a polypropylén/uhlíkové nanotrubičky kompozitných vlákien, ako aj na hodnotenie ich štruktúry a vybraných mechanických vlastností. V článku je diskutovaný vplyv materiálového zloženia a podmienok prípravy na zlepšenie mechanických vlastností kompozitných vlákien.

APPLICATION OF THE LONGITUDINAL RESONANCE VIBRATION METHOD FOR AN INVESTIGATION OF A TEXTILE'S VISCO-ELASTIC PROPERTIES

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This paper focuses on an experimental investigation of the visco-elastic properties of textiles under dynamic conditions by the longitudinal resonance vibrations method on a special installation. Analysis of the experimental results illustrates that the visco-elastic properties of textile composites depend on the characteristics of the individual materials. We assume that with knowledge of the visco-elastic properties of individual textile materials in various directions, we can control the anisotropy of multilayer textile properties.

1. Introduction

As is well-known, the structure of textile materials must be stable during exploitations. In some cases with the use of textile material packages or composite materials (which consist of several individual textiles), it is desirable to obtain an isotropy of the mechanical properties of a system in all directions. The formation of certain positive characteristics of multilayer composites depends on the mechanical (visco-elastic) properties of each component, their position in the system, and the type of bonding materials [1].

Static and dynamic methods can be used for the definition of the visco-elastic properties of textile materials. The preferred dynamic methods are as follows: they belong among indestructible test methods and are less material and labor-intensive. They allow for the reusing of samples of textiles for investigation of their initial properties and properties under influence of exploitation factors.

The dynamic module of elasticity and the logarithmic decrement of attenuation characterize visco-elastic properties. The dynamic module is the characteristic of their deformative properties and measure of their material stability upon external mechanical loadings; the logarithmic decrement is a measure of energy, which dissipates as heat [2].

The aim of the investigation is the determination of the possibility of applying the longitudinal resonance vibration method for research and control of the visco-elastic properties of the isotropy of multilayer textiles.

2. Experimental

2.1 Textile materials

Two kinds of initial materials were investigated:

1. sample "S" - polypropylene (PP) loose knitted fabric,
2. sample "Sh" - two-sided adhesive web "Sharnet" (ethylene-vinyl-acetate (EVA)).

   Also, two types of textile composites were obtained and investigated:

1. first type - "S - Sh" bonded in a "warp - warp" direction;
2. second type - "S - Sh - S" bonded in different directions (Table 1).

The textile composites were prepared on laboratory equipment without the use of water vapor. The optimal bonding conditions were chosen during preliminary investigations: the bond line temperature - 130°C the pressure applied - 0.05 MPa and the exposure time under heat and pressure - 15 sec.

Some characteristic of the initial textiles and textile composites are provided in Table 1.

Table 1 Structural performance of initial textile and textile composites

№	Properties	Sample code			
		S	**Sh**	**S - Sh**	**S - Sh - S**
1	Type of textiles	knitted fabric	adhesive web	textile composites	
2	Raw composition, %	PP-100	EVA-100	S - Sh	S - Sh - S
3	Directions of bonding	-	-	warp - **warp**	1. warp - **warp** 2. warp - **45° angle** 3. warp - **weft**
4	Surface density, g/m^2	95	20	115	210
5	Thickness, mm	0.60	0.02	0.50	0.80

2.2 Research Methods

The visco-elastic characteristics of individual textiles and textile composites under dynamic conditions were investigated by the method of longitudinal resonance vibrations. This method allows for the determination of the visco-elastic properties of fibers, films and fabrics (the installation was carried out and produced at the Kiev National University of Technologies and Design - author V.V. Kostrickij) [3].

The following visco-elastic characteristics were determined during the investigation:

- dynamic module of elasticity (E_d, MPa);
- logarithmic decrement of attenuation (δ);
- dynamic rigidity (D, μN.m^2).

The installation has a PC- program that allows for the calculation and plotting polar diagrams of the dynamic module of elasticity and decrement of attenuation for textiles in various directions (Fig. 2).

This method, by using mathematical processing of the experimental data, allows for the calculating and plotting of polar diagrams of the dynamic module of elasticity and decrement of attenuation for textiles in various directions.

The "**S - Sh**" sample (Table 1) was received for investigation of the "Sharnet" adhesive web's influence on the visco-elastic properties of the multilayer textiles. In this sample the textile layers are located in their longitudinal direction relative to each other (warp - warp). The diagram (Fig. 2, b.) shows that the "**S - Sh**" sample has similar character fields of the module of the elasticity's distribution as the "**S**" sample (Fig. 2, a.). Thus we can see the increase in the adhesive web's module of elasticity and rigidity (Table 3), but that does not change their warp's clear-cut character. The dynamic module of elasticity of "**S - Sh**" sample is 2-3 times greater in all directions in comparison with this parameter for the "**S**" knitted fabric. Thus, the "Sharnet" adhesive web has an effect on the value of the visco-elastic properties of an initial textile, but the character of their distribution in different directions of measurement does not change.

The "**S - Sh - S**" sample (Table 1) was received for investigation of the effect of the mutual position of the initial textile on the visco-elastic properties of the multilayer textiles:

1. The first type of composite (Fig. 2, c.) - the textile

Table 2 Technical installation data

1. Kind of vibration	longitudinal
2. Range of sinusoidal vibration of frequencies, Hz	0.1-2000
3. Error of measurement of vibration period, %	0.25
4. Error of resonance moment registration, s	10^{-5}
5. Distance between clamp claws, mm	10-200
6. The maximal thickness of a sample, mm	3

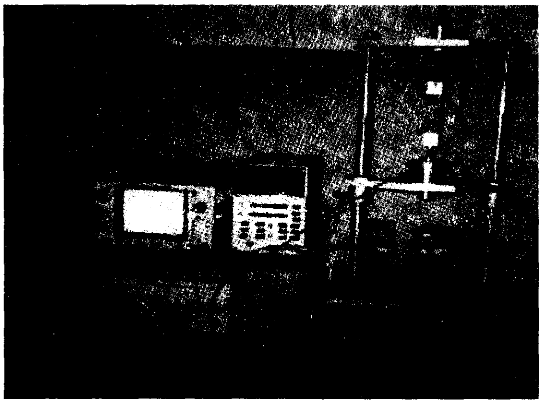

Fig. 1 Installation for investigation of visco-elastic properties

3. Results and discussion

The visco-elastic properties of textiles are measured in three directions - on a warp, on a 45° angle and on a weft (Fig. 2). The knitted fabric "**S**" is characterized by the anisotropy of the visco-elastic properties (Fig. 2, a.) and has a warp of a clear-cut character.

layers are located along their longitudinal direction relative to each other (("**S – Sh – S**" sample) (warp - warp));

2. The second type of composite (Fig. 2, d.) - the second textile layer is located under an angle 45° relative to the first textile layer (("**S – Sh – S**" sample) (warp - 45° angle));
3. The third type of composite (Fig. 2, e.) - the second textile layer is located under an angle 90° relative to first textile layer (("**S – Sh – S**" sample) (warp - weft)).

It is interesting to note that the value of the dynamic module of elasticity of all the composite materials increase 6-13 times in comparison with this parameter for a "**S**" knitted fabric - the composite materials became more rigid (an increase in dynamic rigidity of 12-20 times) (Table 3).

The diagrams (Fig. 2) show that the visco-elastic properties of multilayer textiles depend on the individual materials' characteristics as well as their mutual position; also they depend on a kind of adhesive web. The results of the investigations show that the application of the longitudinal resonance vibrations method allows for the estimation and control the anisotropy of the visco-elastic properties of composite materials.

As the diagrams show, the first type of composite (Fig.2, c.) is characterized by a warp of a clear-cut character. This is due to the mutual position of both layers (warp - warp). The initial knitted fabric "**S**" has the largest value of the module of elasticity in a warp direction.

The analysis of the experimental data concerning the second type of composite (Fig. 2, d.) shows that this sample has a diagonally dominant character. This maybe explained by the mutual position of the second layer relative to the first layer (warp - 45° angle).

The analysis of the dynamic module of elasticity distribution diagrams of the composite materials has shown that the composite with an arrangement of layers "warp - weft" ("**S – Sh – S**" sample (Fig. 2, e.)) is characterized by the highest degree of isotropy with regard to the "dynamic module of elasticity" parameter and "dynamic rigidity".

As was discussed above, the logarithmic decrement is a measure of energy which dissipates as heat and characterizes the looseness of the material structure. As one can see, all the composite materials have a nearly equal value of the logarithmic decrement of attenuation. Also, all the composites have similar characteristic fields of logarithmic decrement distribution (Fig.2 , h, l, m). This experimental data indicates that all the multilayer textiles have equal looseness, which is the result of using the same initial textiles and obtaining the same conditions.

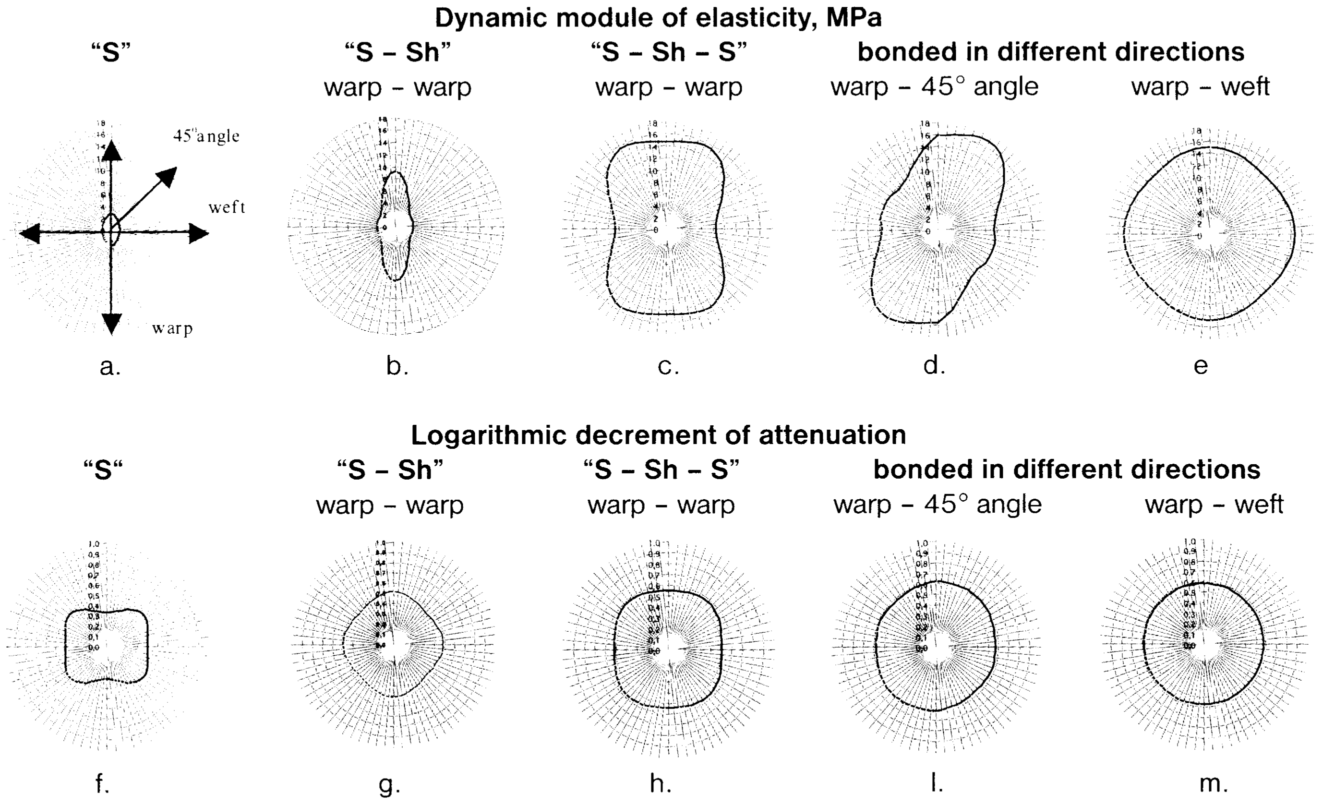

Fig. 2 Visco-elastic characteristics of the initial textile and composites

Table 3 Visco-elastic characteristics of the initial textile and composites

Sample code	Direction of measurement	Dynamic module of elasticity, E_d, MPa	Dynamic rigidity, D, $\mu N.m^2$
"S"	warp	2.55	1.38
	45° angle	1.66	0.90
	weft	1.24	0.67
"S - Sh"	warp	9.08	2.84
	45° angle	3.38	1.06
	weft	3.00	0.94
"S - Sh - S" (warp - warp)	warp	1.56	18.64
	45° angle	13.86	17.74
	weft	8.55	10.94
"S - Sh - S" (warp - angle 45°)	warp	15.70	20.10
	45° angle	15.70	20.10
	weft	9.47	12.12
"S - Sh - S" (warp - weft)	warp	14.86	19.02
	45° angle	13.86	17.74
	weft	14.86	19.02

4. Conclusions

The experimental data shows that the visco-elastic properties of multilayer textiles depend on the initial materials' characteristics and their mutual position. The results of the investigations also show that the application of the longitudinal resonance vibrations method allows the estimation and control of the anisotropy of the visco-elastic properties of composite materials.

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Použitie metódy pozdĺžnej vibračnej rezonancie pre výskum textilných viskoelastických vlastností

Translation of abstract:

Application of longitudinal resonance vibration method for investigation of textile visco-elastic properties

Príspevok sa zameriava na experimentálny výskum viskoelastických vlastností textílií za dynamických podmienok metódou pozdĺžnej vibračnej rezonancie na špeciálnom zariadení. Analýza experimentálnych údajov ukazuje na fakt, že viskoelastické vlastnosti textilných kompozitov závisia na charakteristikách jednotlivých materiálov. Predpokladáme, že poznaním viskoelastických vlastností jednotlivých textilných materiálov v rôznych smeroch môžeme kontrolovať anizotropiu vlastností viacvrstvových textílií.

IMPACT OF DIRECTIONS ON FRICTIONAL PROPERTIES OF A KNITTED FABRIC

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The slip of a textile fabric to a similar fabric probably depends on the direction due to the anisotropy of the fabric's structure and surface geometry. The effect of the actual mutual fabrics' position is important as well as the surface profile substantively changes in the course of a slip. The exact theoretical calculation of the frictional resistance for knitted fabrics is difficult, so an experimental approach is preferred in the contribution. Periodical changes in the frictional resistance that are followed by a change in the mutual fabrics' speed, are measured and proved to relate to the periodicity of the knitted fabric's structure, mainly at a great lateral pressure. A lower mutual pressure is, on the contrary, attached to the greater impact of the fabric's hairiness.

1. Introduction

Sometimes frictional resistance can be predicted with a sufficient exactness of the results (for example, the friction of steel to steel, when the surface quality and lubrication are known). Nevertheless, an often used assumption that friction does not depend on the slipping area, is not valid in general. Friction, on the level of elementary particles [2, 3], is based on the mutual forces between these particles, and the number of such forces, of course, depends on the slipping area, but not on the apparent "overall" area, but on the area of the real contact. This area depends on the normal tension between slipping bodies as well as on many other variable parameters such as the surface relief of the slipping bodies, the speed of the slip, direction, humidity, etc. As the surface geometry of knitted fabrics is very complicated and direction dependent (anisotropic), the exact calculation of frictional resistance is still not possible.

Another problem, which is related to the predicted friction offibres, is connected with the fibrous surface quality. It is known that quite another is the friction of solid bodies (Coulomb friction) and the friction of liquids (viscous friction - Newton's law). The usual textile fibre surface is somewhere between these ideal variations; let us take into consideration wax on a cotton fibre's upper layer, fat on wool, different lubricating agents, etc. These are the main reasons why an experimental approach, supported with some not exactly described assumptions, was chosen for this contribution.

2. Assumptions

Stress will be put on the effect of directions on frictional resistance, because anisotropy is a very characteristic property of knitted structures. The example of a knitted fabric to the same knitted fabric's slip will be analysed. It may be assumed that frictional resistance could increase if the direction of the segments of the yarns on the fabric surface would be approximately perpendicular to the direction of the mutual fabrics' slip. In this case, the direction of normal force between the areas of contact periodically changes, and the length of the actual slip could be longer. A simple model is shown in Fig. 1, where F_n is the overall normal force, F_t is the tangential force (the overall force of the frictional resistance), v is the actual speed of the upper body's movement, and β is the angle of the bodies' surface in contact.

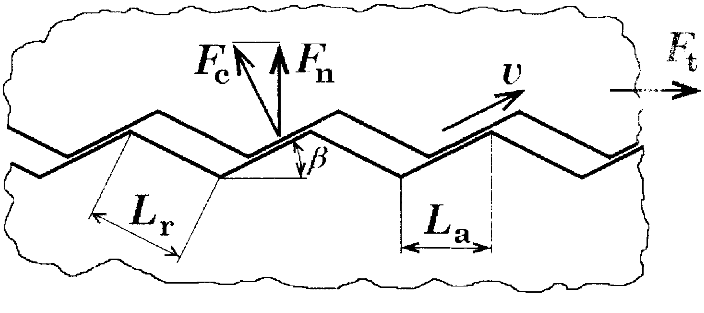

Fig. 1 Simple model of the effect of surface relief on frictional resistance.

Let L_a be the length of the apparent mutual movement and L_r the length of the actual slip. It will be

$$\frac{L_r}{L_a} = \frac{1}{\cos\beta}. \tag{1}$$

As well, the force of the actual contact Fc is higher than the overall normal force Fn and needs to be recounted:

$$F_c = F_n \frac{1}{\cos\beta}. \tag{2}$$

As the actual length of the path is longer and the actual normal force is greater compared with the overall apparent parameters, the frictional energy losses Wβ at angle β would be higher than the losses in the case of flat surface W0 when β = 0:

$$W_{\hat{a}} = W_0 \frac{1}{\cos^2\beta}. \tag{3}$$

Unfortunately the actual angle β is variable, and its average value is not known.

What could be the effect of a knitted fabric's structure on frictional resistance? A higher friction coefficient could be predicted on the slip of the reverse side of a plain weft knitted fabric over the reverse side of a similar fabric if it moves in the direction of the wales; movement in the direction of the courses should be connected with a lower frictional resistance. Face-to--face sides could be accompanied with higher friction when the slip occurs in the direction of the courses on both fabrics.

From the point of view of the structure, the unevenness of the surface of the fabrics can have different resources at different levels:

a) **The level of the fibres** can be described by the fabric's hairiness. It could be assumed that this level will be important mainly at a low value of normal tension. The direction of the interactive forces between fibres in contact could be similar to the direction of the fabrics' slip; so an important part of these forces could generate frictional resistance. If two fabrics are near each other but if the normal force is still zero, some frictional resistance could be assumed due to the material's adhesion. In this case the coefficient of friction μ will be unlimited (μ → ∞). Friction on this level will probably be more chaotic with a lower dependence on the direction.

b) **Level of yarns** or geometry of a fabric's surface structure. This becomes more important with higher lateral tension and is likely more systematic with some impact of the direction and mutual position of the fabrics. Two critical simplified situations are shown in Fig. 2.

b1) If approximately parallel parts of the surface yarns are in contact, the normal direction could be inclined and could have some component on the direction of slip v. In Figs. a, b, and c, the force F_1 is external (F_{n1} normal force, F_{t1} tangential frictional resistance in the direction opposite to the fabric's slip) and the force F_2 is an internal one (again F_{n2} is normal and F_{t2} is a tangential component of F_2). The deflection of the force F_{n2} from F_{n1} by angle α in the opposite direction to the slip substantively increases the frictional force F_{t1}, (ϕ is the frictional angle, Fig. a). When the forces F_{n2} and F_{n1} are parallel (Fig. b), the frictional resistance will be defined only by the ordinary friction coefficient and frictional angle ϕ. If the angle between forces F_{n2} and F_{n1} is opposite, the frictional resistance could be reduced or even negative (Fig. c)

b2) When the cuts of the yarns are parallel to the slip's direction (Fig. d, the slip is perpendicular to the plane of the figure), the sum of the internal normal forces $F_{n21} + F_{n22}$ is greater than the external normal force F_{n1}, and in such a way, the frictional resistance grows (the so-called "flute" friction).

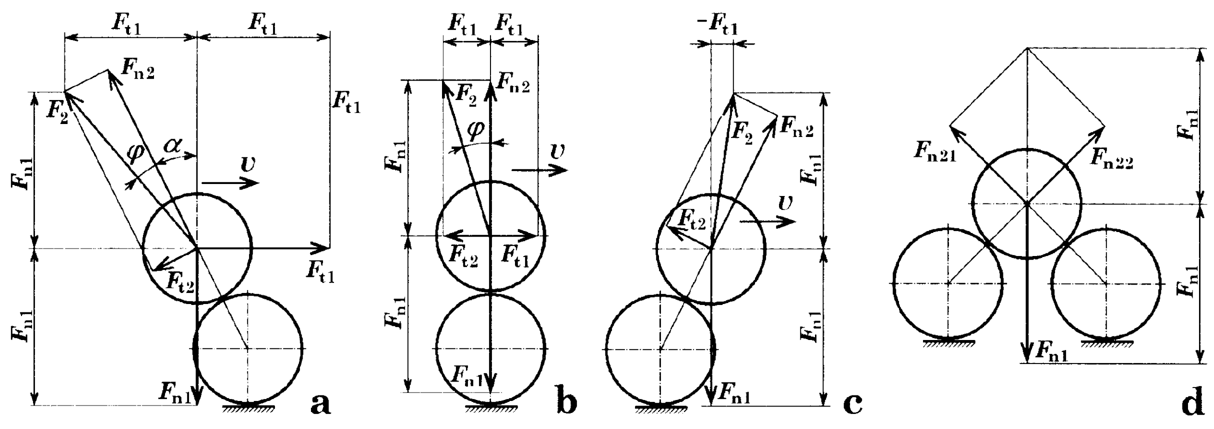

Fig. 2 Impact of surface geometry on frictional resistance.

3. Experimental

A plain single-faced structure was chosen for the first experiments. Three directions and combinations of the face and reverse contact sides of the fabrics were tested. The method is shown in Fig. 3. Upper fabric 1 is kept on the body 3 of mass m_1 (the normal force equals gravity force F_g, change is enabled by using different weights). The overall area of contact was 50 by 50 mm. Body 3 was pulled in the direction of the speed of the slip v_s by a dynamometer (INSTRON 4411) crosshead and by string 5; 4 is the dynamometer sensor of capacity 5 N. The lower fabric 2 was fixed on the plate in one of three positions to the slip's direction - wales, diagonal and courses.

The friction of the pulley 6 on the miniature ball bearing was negligible. The speed of the slip v_s and speed of the drive (crosshead) v_d could be different if string 5's length is changeable (for example by its elasticity). In order to receive a detailed course of the frictional resistance, the data input frequency was set at 0.1 mm. This means that within 20 mm of the slip, approximately 400 points were registered. The usual slip speed was 1 mm s^{-1}. Two knitted fabrics were tested.

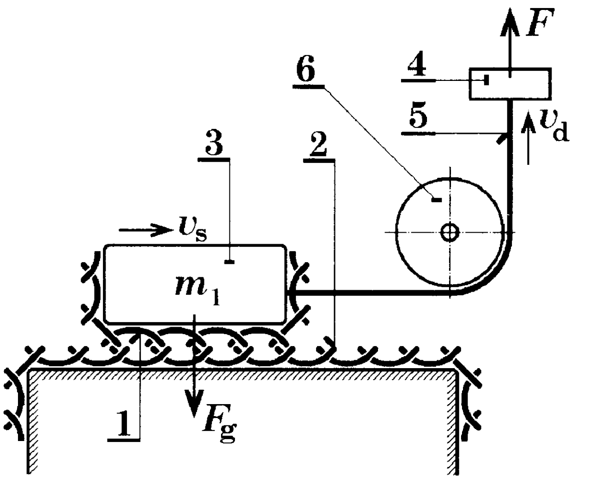

Fig. 3 Scheme of the experiment.

3.1 Fabric A

Brief specification of fabric: Plain single-faced structure, density of wales: 250 m^{-1}, density of courses 370 m^{-1}, stitch length: l_s = 14,2 mm. Yarn: cotton double twisted, two ends in a guide, linear density T = 71 tex x 2. The main results are in Table 1:

In table F_n the normal load per square 50 x 50 mm was set by the weight at values of 50, 100, 200, 400 and 600 N, which corresponds with a normal tension of approx. 200, 400, 800, 1600 and 2400 Pa respectively.

The indexes 1234 in the first colon mean:

1 - Position of upper fabric 1, Fig. 2 (F - face, R - reverse), toward the opposite fabric.
2 - Position of lower fabric 2, Fig. 2 (F - face, R - reverse), toward the opposite fabric.
3 - Direction of slip towards upper fabric 1 position (W - wales, C - courses).
4 - Direction of slip towards lower fabric 2 position (W - wales, D - diagonal, C - courses).

In Table 1 the average values of the particular examples are presented. Nevertheless, the variations in the frictional resistance in the course of the experiment are important as well, because they describe the unevenness of the friction. The coefficients of variation (CV) are shown in Table 2.

Several examples of the measured frictional resistance are shown in Fig. 4. Fig. 4 shows the impact of the density of the fabric courses on the periodicity in the frictional resistance, when the lateral pressure is high and the slip occurs in direction of the wales of both fabrics.

Table 1 Average values of friction coefficient μ [1. 5]

F_n [mN]	50	100	200	400	600	F_n [mN]	50	100	200	400	600
FFCW	1.932	1.513	1.208	0.992	0.879	FRWW	1.958	1.522	1.228	0.987	0.862
FFCD	1.896	1.493	1.209	0.991	0.872	FRWD	1.896	1.547	1.219	0.987	0.900
FFCC	1.932	1.523	1.232	1.006	0.890	FRWC	1.946	1.491	1.223	1.017	0.922
FFWW	2.128	1.696	1.352	1.065	0.928	RRCW	1.870	1.454	1.151	0.946	0.836
FFWD	2.026	1.591	1.252	1.002	0.861	RRCD	2.032	1.492	1.233	0.978	0.860
FFWC	2.002	1.572	1.252	0.994	0.864	RRCC	2.140	1.609	1.292	1.054	0.928
FRCW	1.935	1.605	1.277	1.040	0.945	RRWW	2.426	1.837	1.475	1.156	1.035
FRCD	1.873	1.451	1.196	0.974	0.873	RRWD	2.190	1.688	1.359	1.075	0.974
FRCC	1.752	1.402	1.151	0.927	0.834	RRWC	2.482	1.852	1.423	1.127	0.98

Table 2 Coefficients of friction variation CV [%]

Fn [mN]	50	100	200	400	600	Fn [mN]	50	100	200	400	600
FFCW	4.2	3.1	3.7	1.7	1.5	FRWW	5.1	3.9	2.5	3.6	2.6
FFCD	5.0	2.9	2.2	2.1	2.2	FRWD	5.2	4.3	3.4	2.2	3.1
FFCC	5.2	4.8	3.6	2.4	2.6	FRWC	3.9	3.2	2.6	2.5	3.6
FFWW	3.8	2.6	2.7	2.4	1.6	RRCW	3.6	3.3	3.4	3.0	2.0
FFWD	4.6	4.0	3.1	2.4	2.7	RRCD	5.0	4.0	2.5	1.7	2.3
FFWC	4.6	2.9	3.0	2.6	2.4	RRCC	3.6	3.8	2.1	2.1	2.2
FRCW	6.1	3.7	3.2	2.1	3.9	RRWW	5.9	3.2	2.0	2.4	2.9
FRCD	5.4	3.1	3.0	2.6	1.8	RRWD	4.6	3.4	3.2	2.3	2.2
FRCC	4.6	3.8	3.2	2.6	4.2	RRWC	6.9	3.5	2.3	2.9	2.3

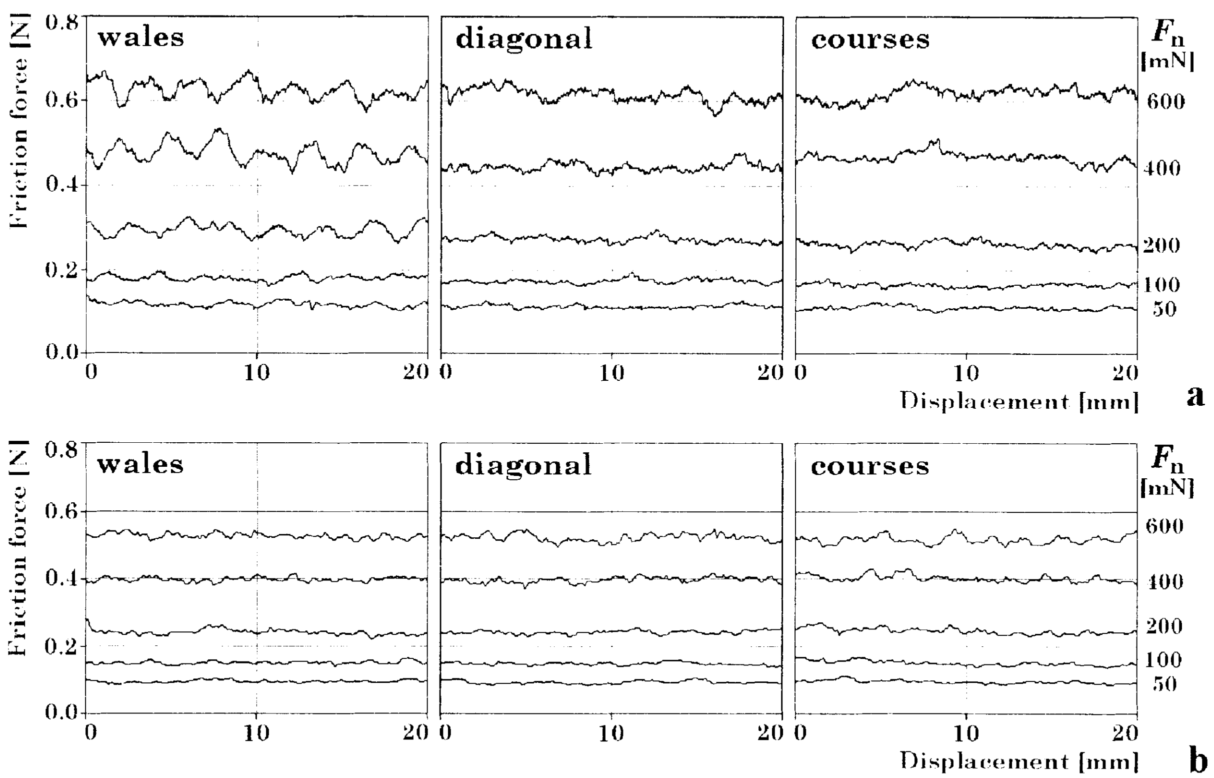

Fig. 4 The course of the frictional force: a) reverse-to-reverse side of the fabric, upper fabric slip in the wales direction, lower fabric in wales, diagonal and course directions, b) face-to-face side of the fabric, upper fabric slip in the course directions, lower fabric in wales, diagonal and course directions

The charts in Fig. 5 shows the average values of the coefficient of friction μ and the coefficient of the variations CV. The results are calculated as average values for the reverse-to-reverse (R-R) and face-to-face (F-F) sides of the fabrics' slip. Fig. 6 shows an example of more particular results, showing the low impact of the direction.

3.2 Fabric B [1, 5]

Brief specification of fabric:
Plain single-faced structure, density of wales 460 m^{-1}, density of courses 540m-1, stitch length l_s = 7,2 mm.

Yarn: acrylic double twisted, linear density T = 32 tex x 2.

The chart in Fig. 7 shows the average values of the coefficient of friction μ and the corresponding coefficient of variations CV, calculated in a similar way as in the previous chapter (R - reverse, F - face side of the fabric).

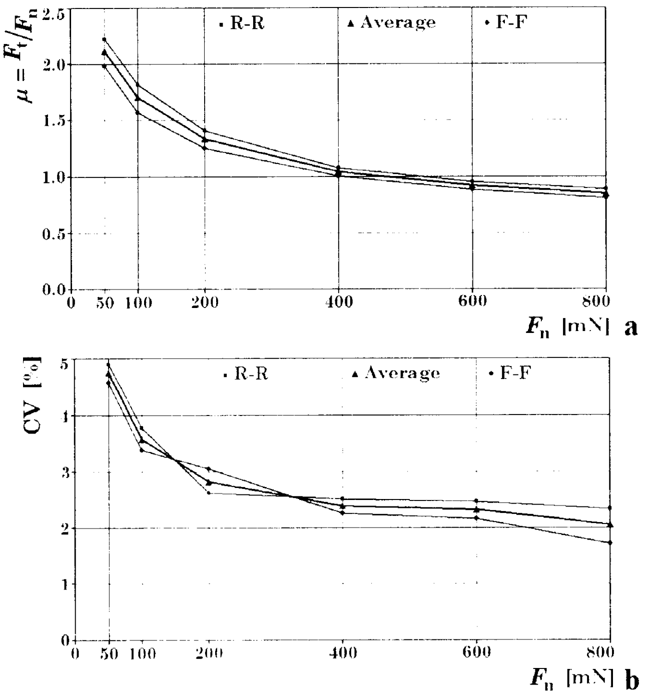

Fig. 5 Impact of normal force on μ and on CV, average values of reverse-to-reverse and face-to-face sides.

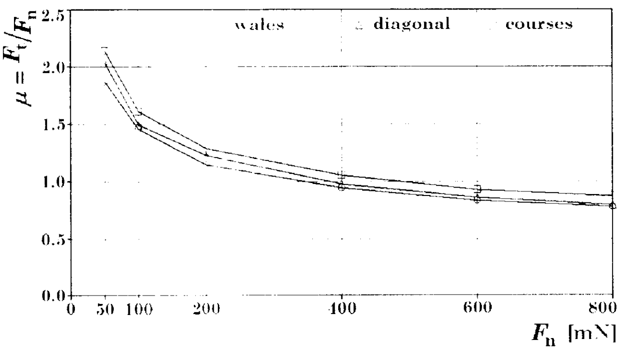

Fig. 6 Impact of normal force on μ, reverse-to-reverse face side of the fabric, upper fabric slip in courses, lower fabric in different directions

4. Discussion and conclusions

The results only partly prove the assumptions. The impact of the direction and change of the mutual positions through the course of the experiment was much lower than was assumed. The coefficients of the variation were lower at a higher normal force (Figs. 5, 7), although the impact of the fabric's structure should be more important. Probably, the effect of the fabric's hairiness on the friction's unevenness is more important.

Nevertheless, some experiments strictly supported the theoretical assumptions. For example, in the case of a face-to-face slip, higher friction was observed for the direction of the wales of both fabrics (assumption b2, Chapter 2). Fig. 4 shows, especially at a higher lateral tension, periodical changes corresponding with

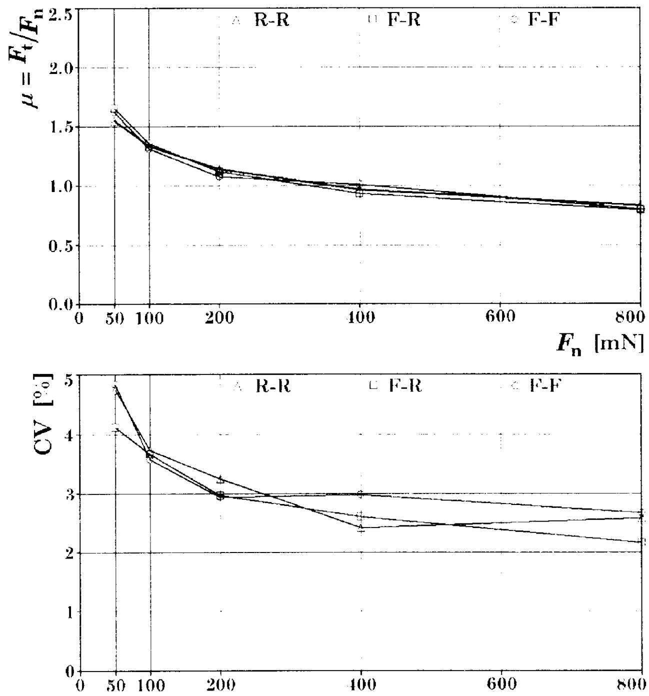

Fig. 7 Impact of normal force on μ and on CV, average values of reversed-to-reverse, face-to- reverse and face-to-face side experiments.

the density of the fabric courses. As assumed, this position (reverse-to-reverse, direction of wales) is critical, because the segments of the yarns of the lower and upper fabrics are parallel, and the speed of the slip is in a perpendicular direction. Such examples are worthy of spectral analysis. An example is introduced in Fig. 8; the main peak corresponds with the density of the courses of the fabric.

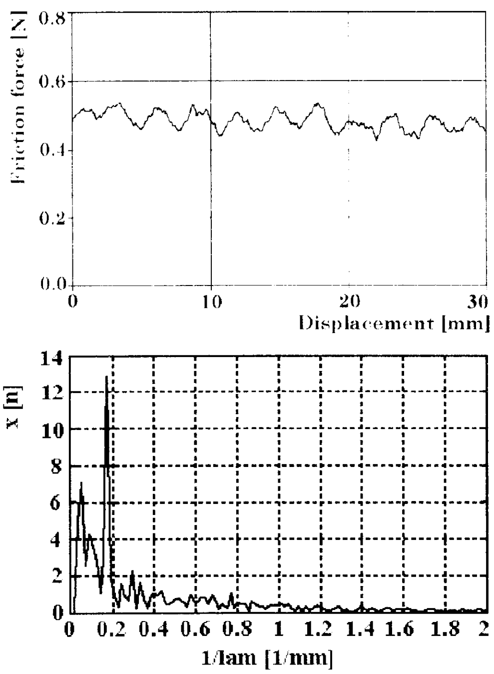

Fig. 8 An example of FFT (Fast Fourier Transformation) [1, 5]

In comparison with the friction of woven fabrics [4], in this case, the effect of the direction is much lower. It would be possible to repeat similar experiments on a model knitted fabric made of very even yarn (a monofilament). It would be interested to measure the friction of two different fabrics as well. Another effect that could be evaluated is the elasticity of string 5 (Fig. 3). An attempt which was already carried out by implementation of a spring between the string and dynamometer sensor shows a great change in the fabric's speed and in the frictional resistance characteristics.

Acknowledgement: *This work was supported by the "Research Centre Textile"project* 1M4674788501 of the Czech Ministry of Education.

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Vliv směru na třecí vlastnosti pleteniny

Translation of abstract:
Impact of Direction on Knitted Fabric Friction

Posouvání se plošné textilie po podobné plošné textilii pravděpodobně závisí, s ohledem na anizotropii struktury a povrchové geometrie, na směru smýkání. Důležitý bude také vliv okamžité vzájemné polohy obou textilií, neboť se geometrie jejich povrchu v průběhu smýkání mění. Exaktní teoretický výpočet třecího odporu pletenin je obtížný, proto byla dána přednost experimentálnímu přístupu. Periodické změny třecího odporu, které jsou doprovázeny změnou vzájemné rychlosti, byly měřeny a prokázaly vliv periodicity struktury, a to především pro větší normálové napětí. Tření při menším vzájemném přítlaku je naopak ovlivněno chlupatostí textilie.

THE DYNAMICS OF YARN TENSION IN WARP KNITTING

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In order to establish the dependence of warp yarn on a knitting machine's operating speed within the compensation and knitting zones, as well as in certain characteristic phases of loop-forming processes, we have studied the dynamics of warp yarn tension in warp knitting, on a RE-4 rashel knitting machine, by means of sensors constructed particularly for this type of research.

From a dynamic point of view, we obtained an oscillation equation, which determines the connection between the speed of the warp yarn's shifting, the tension mechanism, and the operating speed of the knitting machine, which is of great importance for the stability of warp knitted fabrics. The values of cyclic periods and muffle oscillation process periods are obtained from a differential second-degree equation, which represents an innovation in this field of research.

1. Introduction

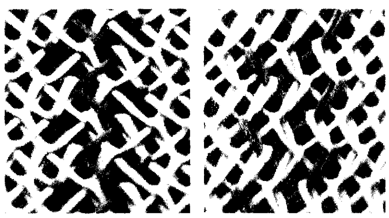
The manufacturing of highly productive warp knitting machines working at high speeds is possible only in conditions of the accurate analysis of the entire technological process, the main element of which is the loop-forming process. In the loop-forming process, the yarn twists round the needles, sinkers and other directional operational parts, and at the same time, the yarn shifts. By twisting, the yarn resists the change in its shape, and deformation, which in most cases causes the yarn to tear, appears.

It is therefore necessary to take into account the importance of determining the yarn tension both in the compensation and knitting zones, during the particular characteristic phases of the loop forming process, which is very important in designing a machine from a dynamic point of view. Shifts in the knitting parts have to be minimal for their lesser inertial loads, by which the machine increases.

The dynamics of yarn tension

A positive method of adding a warp is used on the warp knitting rashel machine, the "Super Garant" RE-4, from K. Mayer's firm, which operate at low speeds.

The machine was used for processing polyester yarn with a longitudinal mass of 19. 53 tex in a Taft weave. The appearance of the Taft braids' front and rear is given in Fig. 1.



a b

Fig. 1 The photo of Taft braids front (a) and rear (b)

During a cycle of forming loops which is caused by the comparative removal of needles, the yarn consumption changes. Unless the warp mechanism provides for a change in an additional quantity in accordance with its consumption during the knitting, the yarn tension (of the warp) will essentially change during the loop-forming cycle.

Let us examine the technological chart of the object (Fig. 2.) with a passive warp addition without the drawing mechanism in the warp yarn 1, which they have in warp beam (shaft) 2, tension T_1, outlet it to point A at speed υ and let off further to point B of the knitting zone, wherein they interlace at speed υ_2.

The warp beam reverses at the angle speed ω. From the given chart it is necessary to define the yarn tension T_2 in zone AB = L, depending on the variable tension T_1, the outlet yarn's speed from zone $\upsilon_2=f(t)$, break moment M, and other causes.

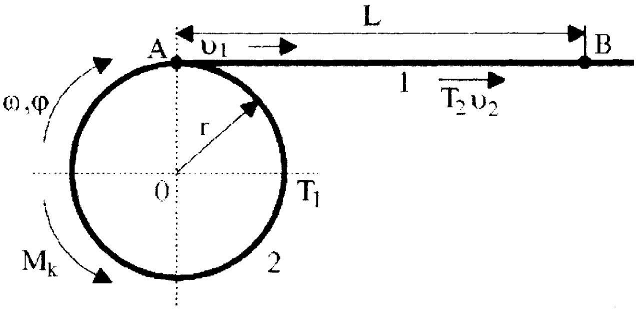


Fig. 2 Technological chart of the object with the passive addition of warp yarn without elongation

To solve the problem, we have to assume that:
- The warp yarn's friction against the drawing mechanism and other directional devices is negligibly small,
- the "damping" of the elongation mechanism in the dynamic system is proportional to the speed,
- the yarn tension has values which correspond to the areas of their elasticity speeds,
- the elongation mechanism is balanced, i.e, the moment of the force of gravity equals zero,
- the diameter of the elongation mechanism is small.

In order to determine the differential equation of the warp yarn's tension in the machine's compensation zone, we will use the shifted yarn's equlibrium volume, considering that for a certain duration of time dt between the yarn volume V_1, which inlets the zone AB from the warp beam, and yarn volume V_2, which outlets that zone, as a result of the loop-forming. There is a change in yarn volume dV, which is caused by the shifting of their cross-sections in the deformation process which, on the other hand, is caused by their elongation during the time dt to Td_2. Then, $dV=LdT_2$. In the given example, AB=L=const, L-the length of the warp yarns between the two fixed points, the length of which does not change.

Volume V_i of a certain yarn piece, at force action T_i is:

$$V_i = V_0\left[\frac{T_i}{ES_0}(1-2\nu)+1\right] \qquad (1)$$

where is:

Vo - the volume of the warp yarns to deformation,

So - cross-section of the warp yarns before deformation,

E - module of the longitudinal yarns' elasticity,

ν - Poisson's coefficient.

The ratio between the volumes of one and the same part of the shifted warp yarns at the change in tension from T_1 to T_2 can be expressed by the following equation:

$$\frac{V_2}{V_1} = \frac{T_2(1-2\nu)+ES_0}{T_1(1-2\nu)+ES_0} \qquad (2)$$

2. Experimental

In the theoretical part we examined the main parameters influential both to the knitting process and the warp knitted fabrics' stability of structure. Extremely relevant is the given relationship which appears between both the yarn volumes before and after the deformation, and their cross-sections during deformation by elongation in the compensation and knitting zones.

We saw above that there is a theoretical dependence between the particular parameters, but it is not known whether these subordinations are experimentally proven on the machine itself during the technological process of production.

In order to solve this problem it was necessary to:
- construct a FS-LJ two - component sensor; LDSM with the possibility of defining the force in the knitting zone and the knitting process itself,
- construct a FS-LJ two-component sensor; LDSM for defining the warp yarns' drawing force at the compensation zone,
- construct a FS-LJ two-component sensor; LDSM for determining the withdrawing force in the knitted fabrics at the immediate knitted fabrics' withdrawing part from the needles to the drawing roller and from the guide roll to the cloth roll [1], [2].

Fig. 3 represents the measuring equipment - sensors with the attached equipment.

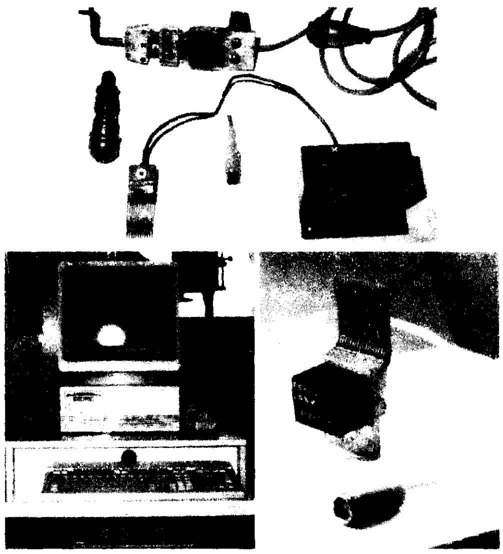


Fig. 3 Represents the measuring equipment - sensors with the attached equipment

Fig. 4 gives the model of a Rachel machine with measuring spots and sensors for measuring the force of the warp yarn tension 2 in the compensation zones I, II, and III, the knitting zone directly on needles 6 and the braid zones IV and V.

The conditional equilibrium volume of the warp yarn at the compensation zone AB, in the insignificantly small time period dt, can be expressed by the equation:

$$S_1 \upsilon_1 \cdot \frac{T_2 (1-2\nu) + ES_0}{T_1 (1-2\nu) + ES_0} dt - S_2 \upsilon_2 dt = L dS_2 \qquad (3)$$

where is: $S_1 = S_0 - \frac{2\nu}{E} T_1 \qquad S_2 = S_0 - \frac{2\nu}{E} T_2$.

-Cross-sections of the warp yarns' surfaces during the elongations T_1 and T_2.

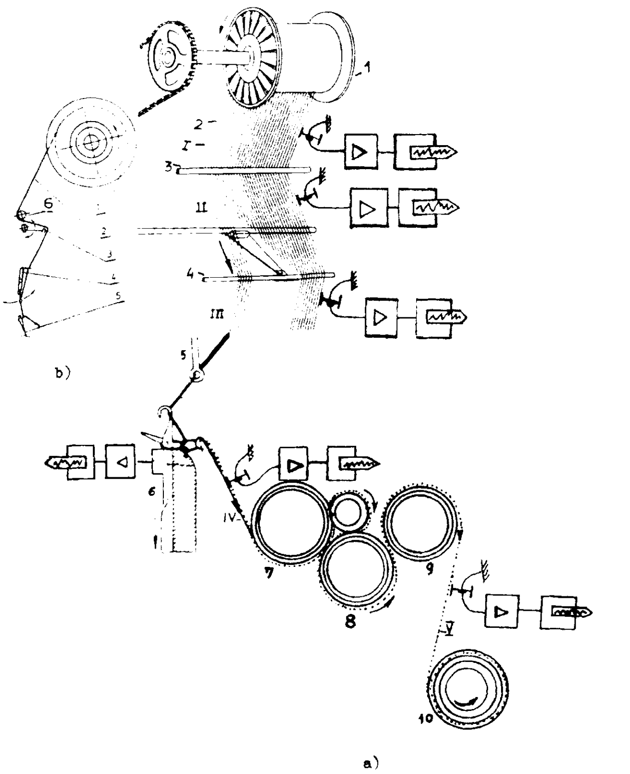


Fig. 4 The model of a Rachel machine with measuring spots and sensors for measuring the force

Legend:

1-Bobbin; 2-Warp; I-Compensation zone; 3-Orientation rod; II-Compensation zone; 4-Tension mechanism; III-Compensation zone; 5-Warp depositor; 6-A needle with the sensor built in; IV-Braid; 7-Entrain runner; 8, 9-Orientation runners; V-Compensation zone; 10-Goods runner.

By exchanging the values S_1, S_2, $dS_2 = -\frac{2\nu}{E} dT_2$ and $\upsilon_1 = r\varphi = r\frac{d\varphi}{dt}$ with equation (3).

$$r(B - 2\nu T_1)[B + (1-2\nu)T_2]\frac{d\varphi}{dt} - \upsilon_2 (B - 2\nu T_2)$$

$$[B + (1 - 2\nu T_1)] = -2\nu L\,[B + (1-2\nu)T_1]\frac{dT_2}{dt} \qquad (4)$$

where is:

ω - angle speed, ϕ - angle rotation of warp shaft, r - radius yarn's at warp shaft, B - warp yarn's stiffness.

The examined system has an equation of direction:

$$I\frac{d\omega}{dt} + \frac{\omega}{2}\frac{dI}{dt} + M_k = T_2\, r \qquad (5)$$

If we differentiate equation (4) per time and derive $d^2\phi / dt^2$ to make a change in (5) where

$$\frac{d^2\varphi}{dt^2} = \frac{1}{I}\left(T_2 r - M_k - \frac{\omega}{2}\frac{dI}{dt}\right) \qquad (6)$$

we will get the complex -structured linear differential second-degree equation

$$2\nu LI[B + (1-2\nu)T_1]\frac{d^2T_2}{dt^2} + 2\nu LI(1-2\nu)\frac{dT_1}{dt}\frac{dT_2}{dt} +$$

$$+ rI(B - 2\nu T_1)(1-2\nu)\omega\frac{dT_2}{dt} + 2\nu\upsilon_2 I[B +$$

$$+ (1-2\nu)T_1]T_2 - I(1-2\nu)\upsilon_2(B - 2\nu T_2)\frac{dT_1}{dt} - 2\nu I[B +$$

$$+ (1-2\nu)T_2]\omega\frac{dT_1}{dt} - I(B - 2\nu)\frac{dT_2}{dt}[B + (1 - \qquad (7)$$

$$-2\nu)T_1]\frac{d\upsilon_2}{dt} + I(B - 2\nu T_1)[B + (1-2\upsilon)T_2]\omega\frac{dr}{dt} +$$

$$+ r(B - 2\nu T_1)[B + (1-2\nu)T_2]\left\{T_2 r - M_k - \frac{\omega}{2}\frac{dI}{dt}\right\} = 0$$

The equation obtained enables us to define tension T2 of the warp yarns regarding their mechanical properties (parameters $B=ES_0$, ν) of the initial tension T_1, parameters I and r and speed $\upsilon_2(t)$. With a change in speed υ_2, the initial tension T_1, inertial moment I and radius r could be considered as eternal obstructing factors, and the change in the break moment could be considered as a control impact.

In order to test the object equation experimentally, we can use the following expression

$$\frac{LAI}{S_0 r^2}\frac{d^2T_2}{dt^2} + \frac{A\upsilon_2 I}{S_0 r^2}\frac{dT_2}{dt} + \left(\frac{AI}{S_0 r^2}\frac{d\upsilon_2}{dt} + 1\right)T_2 =$$

$$\frac{M_k}{r} + \frac{I}{r^2}\frac{d\upsilon_2}{dt} + \frac{\omega}{r}\left(\frac{dI}{dt} - \frac{I}{r}\frac{dr}{dt}\right) \qquad (8)$$

In v_2=const. and with the slow change I= const, r = const if we ignore the last (right) equation of equation (8), we will get:

$$Q\frac{d^2T_2}{dt^2} + R\frac{dT_2}{dt} + T_2 = \frac{1}{r}M_k$$

If we connect the warp yarns' tension forces T_2 to the break moment M_k, the break function can be written as

$$K_{(p)} = \frac{T_{2(p)}}{M_{k(p)}} = \frac{r^{-1}}{Qp^2 + Rp + 1} \qquad (9)$$

From equation (9) we can see that the transfer coefficient of the break function equals r^{-1}, i.e. the standard machine operation regime $T_2 r = M_k$

2.1 Warp yarn tension forces in phases of the loop- forming cycle

Diagrams of yarn tension force with more cycles were obtained through the use of sensors and additional equipment. At the slow motion operating speed of a machine of 8,5 min^{-1}, the cycle period was 7.05s (Picture 5) [6, 10]. The maximum tension is in phases 5, 8 and 0. Phases 5 and 8, which have a maximum tension, correspond to the layer's movement at the final front and back position of the needle board. The yarn tension is maximal at the end of the cooling (phase), when the needles take the lowest position [2].

The minimums of the yarn tension correspond to the cross-sections of the eye hook needles between the latch needles during the back and forth movements (phases 4 and 7), and during the lifting of the needle in the opening of the needle latches (phase 9). The phase of an additional half-loop onto the other part of the needle latches also causes a change in tension (phases 10 and 10a) [3, 4, 5].

Diagram of yarn tension in stages, in compensation zone I, at a knitting speed of 580 min^{-1}.

This method of changing the warp yarn's tension made us test the yarn tension, considering the extent of both the maximum and medium tension.

Table 1 shows the yarn tension forces regarding the phases of loop-forming in the knitting zone, with a slow motion operation of 8.5min^{-1}, and in the compensation zone of 8.5min^{-1} and 580min^{-1} (Fig. 6) [7, 8, 9].

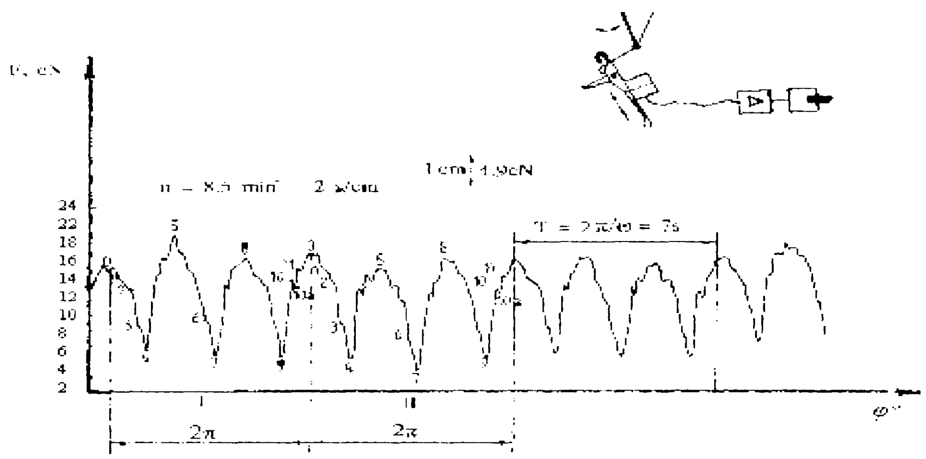


Fig. 5 Diagram of yarn tension in a knitting zone, at a knitting speed of 8. 5 min^{-1}

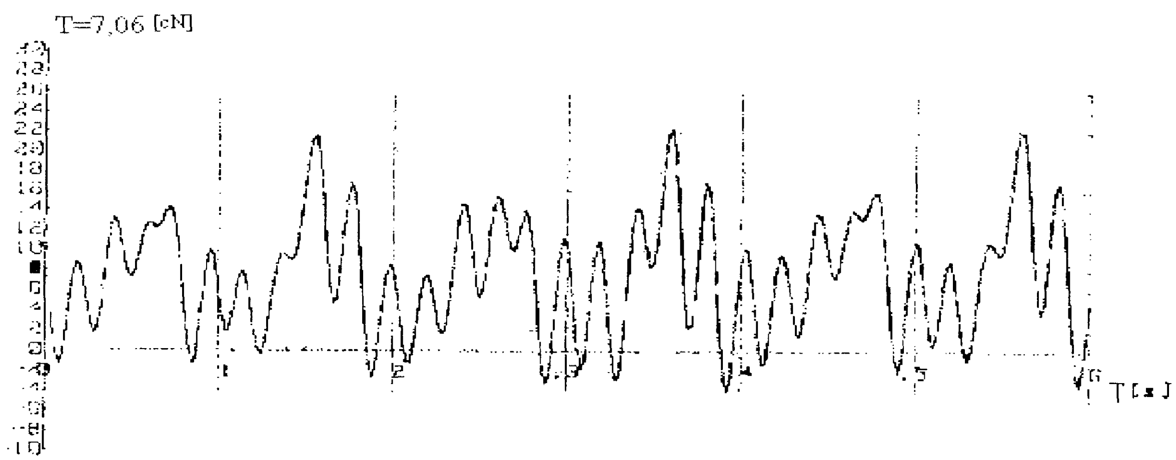


Fig. 6 Diagram of yarn tension in stages, in compensation zone I, at a knitting speed of 580 min^{-1}

Table 1 Yarn tension forces

Phases	Knitting zone 8,5 min^{-1}	Compensation zone 8,5 min^{-1}	Compensation zone 580 min^{-1}
	T (cN)	T (cN)	T (cN)
0	14.21	17.49	21.27
1	13.23	16.51	20.29
2	11.27	14.55	18.33
3	5.39	8.67	12.45
4	1.47	4.75	8.53
5	20.09	23.37	27.15
6	5.88	9.16	12.94
7	0.735	4.01	7.79
8	16.17	19.45	23.23
9	0.49	3.77	7.55
10	12.25	15.53	19.31
10 a	11.27	14.55	18.33
11	14.21	17.49	21.27
	9.743	13.022	16.8

Fig. 7 shows a diagram of yarn oscillation in the loop-forming cycle depending on the yarn tensioning force [12].

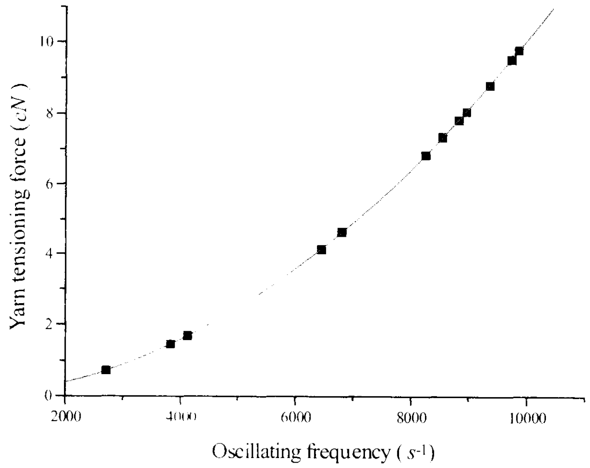


Fig. 7 Diagram of yarn oscillation in the loop-forming cycle depending on the yarn tensioning force.

Fig. 8 shows the dependence of the loop length on the working speed of the machine [2]. We can see that the yarn length in the loom decreases on account of the increased tensioning.

2.2 Conditional periods of a cycle

The modulus of the longitudinal elasticity of polyester yarn, longitudinal weight of 19.53 tex or more correctly. The modules of elastic stiffness are, in the initial stage, determined by the following expression.

$$E_1 = \frac{P_1}{S}\left[cNcm^{-2}\right] \qquad (10)$$

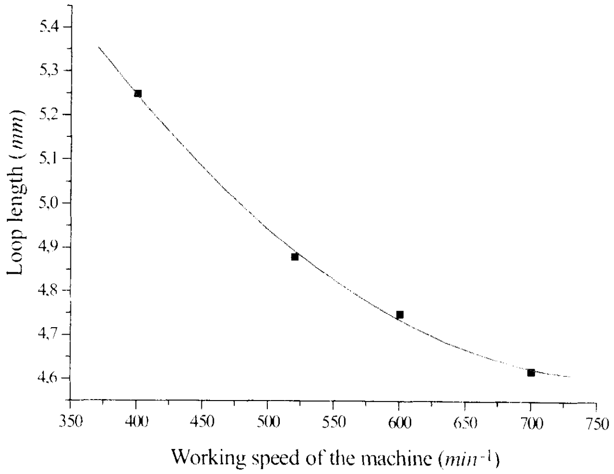


Fig. 8 Diagram of loop length depending on the working speed of the machine

where is: S-surface of the yarn's cross-section cm^2,
P1-yarn load cN of 1 % deformation.

The initial yarn length before elongation was 50cm. In a yarn elongation of 1 %, with a force of 2 cN, the yarn length was 50.5 cm according to the tension diagram.
Since the yarn weight of initial length is 0,0092 g, then the longitudinal yarn weight during the elongation will be:

$$Tt = \frac{0.0092 \cdot 10^3}{0.505} = 18.217 tex$$

and the surface of the yarn's cross-section

$$S = \frac{18{,}217}{1000 \cdot 1{,}38} = 0{,}01320 mm^2$$

which is: 1.38 - is the specific weight of the polyester yarn per mg mm^{-3}.

From the ratio of the force and the surface of the yarn's cross-section, the modulus of elastic stiffness will be:

$$E_1 = \frac{2}{0.01320 \cdot 10^{-2}} = 15151.5\, cNcm^{-2}.$$

According to the dimensions of the warp bobbin and the material's specific weight (out of which the bobbin is made). The inertia moment of the bobbin sten will be:

Ix_1=1/ 12x2.1416x39.5 (10^2-7.75^2)[39.52+3x5.0625] =1392812.5 gr cm^2,

And walss of bobbin:

Ix_2=1/12x2.1416x3.14 (702.25-60.06) x2 [(4+3x351.5625)] =76198.65 gr cm^2, the inertia moment of the yarn warped on the section blocks whose winding warp diameter is 15.1 cm, weight 9.632kg and 1.38gcm^{-3} yarn's specific weight, will be:

I_p=1/12x1.38x3.14x39.5 (15.1^2-10^2) [(39.5^2+3x5.1^2)] =2991276.6gr cm^2

Full moment I_u=0.514606 kg m^2 ili 52457,2 gr cm s^2. Poisson's coefficient is 0.5.
According to equation (9), we have

$$\frac{2\nu T}{100E}=\frac{2\cdot 0.5\cdot 9.743}{100\cdot 76776.98}=1.269\cdot 10^{-6}cm^2$$

Through this, we have fulfilled the condition that

$$\frac{2\nu T}{100E}=<<S.$$

Determined on the basis of the average force of A loop-forming cycle, table 1.

$$Q=\frac{LI2\nu}{100E_1r^2S}=\frac{52.5\cdot 5475.2\cdot 2\cdot 0.5\cdot 10^2}{100\cdot 76776.98\cdot 15.1^2\cdot 0.01269}=1.293s^2$$

$$R=\frac{\upsilon_2I2\nu}{100E_1r^2S}=\frac{0.5\cdot 5475.2\cdot 2\cdot 0.5\cdot 10^2}{100\cdot 76776.98\cdot 15.1^2\cdot 0.01269}=0.0123s$$

According to equation (9),

$$Q\frac{d^2T_2}{dt^2}+R\frac{dT_2}{dt}+T_2=\frac{1}{r}M_k$$

By changing the values with Q and R, ignoring M_k and with T2=x, we will get

x = k exp (-4.756 x10^{-3} t) cos (0.8794 t + α) .

Coefficient of damping

$$\xi=\frac{0.0123}{\sqrt{1.293\cdot 1}}=0.0108s$$

Since in this example 0< ξ < 1, the oscillation is damping. The tandard logarithm of the relation among the sequenced maximums of the solution or "logarithmic decrement"

$$2\pi h/\omega=0.0339637.$$

According to the diagram of the yarn tension in the knitting zone, at the machine's operating speed of 8,5min^{-1}, a single cycle period amounts to 7.05s, while in the calculation part, a conditional cycle's periods without a break moment amounts 7.14s, which is approximate to the experimental value.

With the average yarn's tension force in a loop-forming cycle of 13cN, the conditional periods of the cycle is 6.215s, and its circular frequency is 1.0104s.

At machine operating speed of 580min^{-1}, the average yarn tension force in the cycle was 16.8cN, the conditional periods of a cycle were 0.0841s, and in the experimental part, it was 0.103s.

3. Conclusions

1. The consumption of the warp yarn during the knitting process, as well as the loop-forming cycle, is a variable value, which is caused both by the comparative shifting laying of the warp and eye hook needles, and the variable warp yarn tension in particular phases of the loop-forming process. This comparatively affects the yarn length of the loop, its stability and the homogeneity of the loop's knitted fabric structure.
2. According to the calculated forces in the compensation zone, as well as in the particular phases of the loop-forming cycle, we have calculated the current modulus of the elastic stiffness as one of the parameters important for defining the conditional periods of the damping oscillation process. At a lower machine operating speed, when the warp yarn loads are the lowest, the conditional periods of a cycle match the experimental one. At higher operation speeds, when the warp yarn loads are greater, there is a small difference between these periods, which varies according to the yarn load.

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Dynamika napätia priadze pri osnovnom pletení

Translation of abstract:
The dynamics of yarn tension in warp knitting

Pre stanovenie závislosti osnovnej priadze na operačnej rýchlosti pletacieho stroja vnútri kompenzačnej a pletacej zóny a tiež v určitých charakteristických uzloch tvorby slučky sa sledovala dynamika napätia osnovnej priadze pri osnovnom pletení na Raschelovom pletacom zariadení RE-4 pomocou senzorov skonštruovaných zvlášť pre tento výskum.

Z dynamického hľadiska sa získala oscilačná rovnicu, ktorá určuje vzťah medzi rýchlosťou posunu osnovnej priadze, mechanizmom napätia a použitou rýchlosťou pletacieho zariadenia, ktorá má veľký význam pre stabilitu osnovne pletených tkanín. Hodnoty cyklických periód a periód oscilácií akustického tlmiča získané z diferenciálnej rovnice druhého rádu predstavujú inováciu v tejto oblasti výskumu.

STRENGTHENING OF THE SEWN SEAM OF PROTECTIVE CLOTHING

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The process of the production of protective clothes for a desiderative purpose requires a knowledge of sewing parameters and the correct choice for the combination of the joined materials. The basic mechanical-physical quality of the joints is solidity. The main sources of the effect on the solidity of the seam in the static are researched. The material used (joining, joined), parameters of the joint, the parameter of the seam and the direction of the strain - are analyzed. The work is engaged in the determination of the longitudinal weight, the number of spins, the solidity and tensibility of the threads at a rip, the finding of the maximum power at the rip of a seam and protective insets and an analysis of the structure of the protective insets of protective clothes for forest workers with saws.

1. Introduction

The development of the methods of analysis to the level of the microstructure of the material, the knowledge of the material engineering and the economically acceptable procedures for the production of formerly only expensive laboratory synthetic materials, enable their constantly wider use in the spectrum of various technical and clothing applications. They are mostly arranged in the categories of technical textiles, and they are put into effect in many branches of human activities, such as the building industry, industry, transport, medicine, sports, health protection and many others.

It is obvious that such materials particularly find use in such products in which their use improves existing qualities and characteristics or adds to them such new utilitarian qualities, which increase the value of the product for the user. The special group from this point of view forms the field of protective and working clothing. And thus also considering the evident profitability of the above-mentioned process, it is obvious that permanent cognition and gaining knowledge about new clothing materials is very important.

However, not only the material preserves the final correct result and also with it the contentment of the customer. The quality of the whole depends on the correct combination of the materials - position, amount and, naturally, on their modification and mainly cooperation, which could not have existed without the most suitable connection of the material.

How do the producers of today master this task? The basic need is - "to know how". Only like this is it possible to define the need of the production itself. The production which needs to get exact and understandable instructions to correctly accomplish the task and allow tolerances, and it has to be adept and by means put these instructions into effect. The task set like this is sufficient for those firms which only carry out the orders of the ordering party, or for a permanently made assortment with a minimum of changes, or for complicated specialized production, where its own competence is an indisputable asset, creating sufficient profit and a position in the competition. However, for firms whose ambition is independent and high-quality operation to the need " to know how", to which it is answered "like this", the need "to know why" has to precede it; this means to have knowledge which enables the creation of the above-mentioned instructions and set allowed tolerances.

How do our Slovak firms find their way in this material, expert and personal context? Associate professor Otakar Kunz, from the Technical University of Liberec, a reputable pedagogue of the Department of Technology and Management of the Ready to wear Production in Prostějov says: „Producers of technical clothing in our country depend on themselves, how to professionally master problems of manufacturing with ready-made-clothes of often new, entirely unknown materials" [1].

Let us take an example from the practice: professional clothes of woodcutters working with chain saws. Their protective clothing cannot provide 100% protection against being cut by chain handsaws (Fig.1). In spite of that it is possible to make protective clothing which provides a certain protective factor. The protection can be achieved by various functional principles [2]:

- slipping of the chain: during the touch with the exterior side of the working means - the chain cuts the material;
- blocking: fibres, are pulled into the chain wheel of the drive by the chain, and they block the chains motion;
- braking of the chain: fibers put up high resistance while cutting, and they absorb the rotational energy and thereby decrease the chain's speed.

rials and, of course, qualities of the seam. After all, making ready-made clothes into the shape of the final product means to process planar textiles with the help of seams into tridimensional products. In the process seams have to resist special and often demanding conditions of the application. When the functionality of the products fails in some cases, health and the human life can be endangered. That is why emphasis is put on the quality of the processing and with it, related requirements for the solidity of the seam, as well as on its basic functional quality.

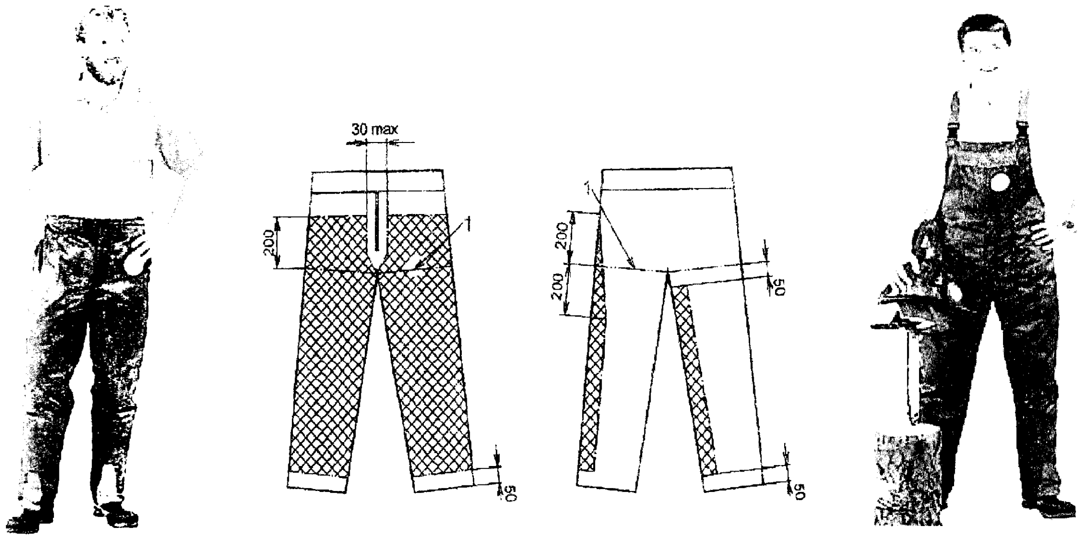

Fig. 1 Protective clothing for users of chain handsaws

The condition for the possibility of making such custom-made technical ready-made clothes according to the customer's supplied procedure from the supplied material in the desiderative quality is the ownership of the quality certificate ISO. One of the most famous cooperative societies in Slovakia - c. s. VZOR Zvolen can be praised for such quality conditions.

What contribution should the knowledge of the supplied sewed and sewing material and qualities of seams of the product for the manufacturing firm have? And what can the educational process contribute? If we return to the previous consideration, we can positively state that such knowledge in the relation to new materials can supplement the produced assortment of actual products by new qualities during their use, or also enlarge the assortment itself. Such knowledge will provide valuable professional information for the tuition at school and its retrieval itself by the process of the analysis as well as practical habits in the training of new specialists. That is why this work has been assigned and accomplished. There have been basic tasks and defined methods of the analysis of mate-

2. Experimental

In order to carry out the examination there eight threads used by producers Reutex, Amann Group and Alterfil were set aside; two kinds of basic material with the rate of PES/cotton - 50/50 and 65/35; two kinds of protective insets (9 and 6- layers); two different lining materials. From the initial basic, layer and lining materials samples for the analysis of seams in 10 combinations with the use of two Amann threads and one inset material were made.

For verifying the qualities of the entering materials into the analysis, verifying of the qualities of the threads (according to STN EN ISO): finding of the length weight by tape method [3]; finding of the thread bend [4]; probing of the solidity and tensibility of constituent threads at break [5] and seams - probing of the maximum power at break of the seam by the Strip method [6] were accomplished.

Seams in clothes drag out, abrade and bend. In accordance with these facts the solidity of the seams characterized by indicators such as the maximum strain by the overspreading of the seam in cross direction, the elongation of the seam at break in the longitudinal direction, resistance of the seam at multiple overspread, along and cross towards the backstitch [6].

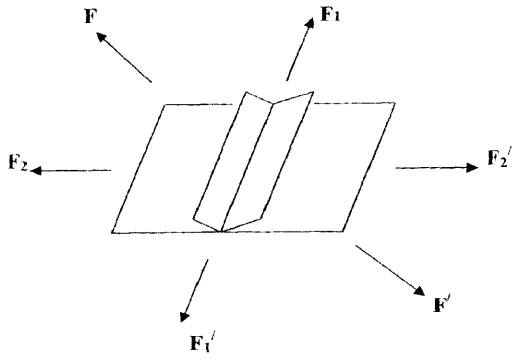

Fig. 2 Schematic representation of the seam strain

In the schematic representation in Fig. 2 there are:

F - is the external power affecting in a common direction;

F_1 (F_1') - external powers affecting the longitudinal direction to the sewed seam;

F_2 (F_2') - external powers affecting the cross direction to the sewed seam.

Maximum strain at the overspread of the seam in the cross direction - is determined on the ripping device. The solidity of the seams depends on the solidity of the threads, the thickness of the threads, the density and kinds of stitches. The simplest formula for the determination of the strain of the tear of a bounded direct backstitch:

$$P = 5.m.Q.\eta$$

where: P - strain needed for the tear, m - number of stitches in 10mm of the backstitch, Q - solidity of the thread, η - correction factor (0.8÷1.2).

The probing of the maximum power of the seam were carried out on the ZT-200 ripping device according to the relevant norm [6]. A test sample of the planar textile with the set size with the stitch in the middle is stretched perpendicularly to the seam by a constant speed till the break of the seam. The maximum power needed for the break of the seam is reduced.

Through this test solidity and tensibility were probed by break of the seam in the direction of the loom and the direction of the weft. The solidity and tensibility by the break of the seam of the materials with 9-layer and 6-layer protective insets was probed.

The sample of the minimum size of 350 x 700 mm will be cut from the planar textile. The sample will be folded in half; thus as the fold was collinear with the longer side of the pattern, the seam will be sewed in this direction. The set of a minimum of five test samples 100mm wide will be cut from the prepared sample, which will be modified into the final form (Fig. 3).

Tests for the probing of the structure of the selected protective insets and linings used in the production of

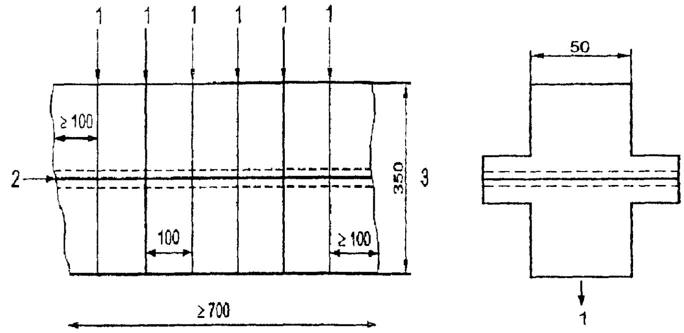

Fig. 3 A sample with a seam and the representation of the division to the test sample (1-cut, 2-seam, 3-length before sewing) and the test sample prepared for the test

the protective clothing for users of chain handsaws were carried out at the Faculty of Industrial Technologies in Púchov and in the Research Institute of Chemical Fibres in Svit. Two protective insets were analyzed. These protective insets are put between the lining materials. The lining material was also analyzed. The macroscopic evaluation was carried out to consider the structure of the protective inset and lining, and the following qualities were determined: form, color, shine and fumble.

While carrying out a combustion test, the method of burning, smell and the rest after burning were determined. The analysis continued by the microscopic test, and it was determined that both protective insets probably have the same looms.

The identification of the materials were carried out according to the methodology described in the company norm [8] PDN 129-97-01. The identification of materials with the use of FT-IR spectroscopy, gas chromatography, microscopy and differential calorimetry, was carried out in the Research Institute of Chemical Fibres in Svit. The determination of the chemical structure of the unknown organic, inorganic and polymeric materials is based on the measurement of the infra-red spectra by transmission or reflective techniques, and the comparisons so obtained spectra with a catalogue of the spectra of known substances. The probable structure of the protective insets and lining was determined by the combination FT-IR spectroscopy with microscopic pictures of the analyzed materials. It was possible to identify only the fibre PE by the differential thermical analysis, where the endothermic effect at 161°C was visible, which corresponds with the temperature of the liquefaction of high molecular polyethylene (cca 170°C) [28]. The second considerable effect from 350 to 450°C corresponds to the thermal destruction of the fibre. With other fibres the DTA method proved to be insufficient as a consequence of the inconsiderable effects in the area of 100°C - 300°C, where it is not possible to identify the characteristic temperatures of the liquefaction of the polymers.

3. Result and discussion

By a comparison of the threads used for sewing the seams of both materials with a different structure it was discovered that the seams sewed by Amann 75 threads for the 50% PES/50% cotton materials achieve the highest values of solidity and tensibility (the seam is led in the direction of the loom).

The highest values of the maximum solidity and tensibility by the rip of the seam were achieved by seams sewed by Amann 75 threads to the 65%PES/35%cotton materials (seam - in the direction of the loom).

After the comparison of the values of the maximum solidity and tensibility by the rip of the seam with the protective insets, the highest values were achieved by Amann 75 threads, which were used for sewing the seam by 50%PES/50%cotton material and a 6-layer protective inset. The Amann 75 thread has a high-solid polyester core, which gives the thread high solidity in the strain and needed extension. The thermal endurance is reached by spinning the core with high-quality cotton.

On the basis of the results of experimental measurements, the highest solidity and tensibility at the rip of a seam in the direction of the loom was achieved by the material with the 50%PES/50%cotton structure (the samples were sewed using the Amann 75 thread). The highest solidity and tensibility at the rip of the seam in the direction of the welf was achieved by the material with the 65%PES/35% cotton structure (Amann 75 thread). The highest solidity and tensibility at the rip of the seam with the protective inset was achieved by the material with the 50%PES/50% cotton structure with a 6-layer protective inset (Amann 75 thread). By carrying out an analysis of the protective insets Advance and 6-layer and lining material their probable structure was determined:

- Advance protective inset in the direction of the loom in polypropylene and polyester, and in the direction of the weft, polypropylene and polyester;
- protective 6-layer inset in the direction of the loom, polypropylene and polyester and in the direction of the weft polypropylene and high-molecular polyethylene;
- lining material mix yarn in the direction of the loom and weft with the cotton/PES structure .

The highest degree of solidity and tensibility by a comparison of the protective insets was achieved by 6-layer protective inset with the structure of the loom PP, PES and the weft PP, high-molecular PE.

4. Conclusions

The data acquired by the analysis of the provided samples have two different values - verification and new information. The first one deals with the qualities of the declared material and belongs to the area of the input control, and the second one offers valuable information about the possibilities for its use. With reference to the second one, it is possible "to assign the material

Table 1 Strain needed for the rip of the direct bounded stitch

Material	Thread used	m	Q	P	Direction/number of the layers of protective. fibres
50% PES, 50% cotton	Amann 80	3	16.7	250.5	loom
	Amann 75	3.5	17.3	302.75	
35%PES, 65% cotton	Amann 80	3	16.7	250.5	
	Amann 75	3.5	17.3	302.75	
50% PES, 50% cotton	Amann 80	3	16.7	250.5	weft
	Amann 75	3.5	17.3	302.75	
35%PES, 65% cotton	Amann 80	3	16.7	250.5	
	Amann 75	3.5	17.3	302.75	
50% PES, 50% cotton	Amann 75	3,5	17.3	302.75	6-layers
35%PES, 65% cotton	Amann 80	3.5	16.7	292.25	9-layers

to the right place", while the preparation of the product means farming out the combination providing a higher quality at fixed expenses.

And what has the pedagogical process acquired? First of all, it has come to the result according to a controlled order and thereby it provided the practical habit acquired by the performance itself for the concrete purpose within the bounds of the expert specialization. For the expert side it provided basic information about the new material - protective insets with the open question of the material structure of one of the components, which creates an expert challenge in the field of material engineering. From the point of view of technical study, measured data is valuable as a component of a wider search, which should be supplemented from the point of view of the amount for statistics. From the point of view of measured combinations for verifying the correct choice of the materials for coming up to the expected utilitarian qualities of the product. However, definite data creates only a part of the expected wider parametrical-material basis in the given issue. Its pedagogical and expert value will grow with its range, and the importance will be potential after the insertion of discovered preferential material-technological combinations to the educational process within the bounds of preparation of new experts for the field of material engineering and teaching technologies.

Work with new materials and practical examples of their use, the effort of mutual usefulness between a firm and school by achieving their own aims and tasks and a certain amount of expert work usable by solving practical questions of the systematization in the new field of the technical clothing are that the profit of similar activities like carrying out of diploma projects. Accordingly, the accomplishment of the correctly chosen contributing assignment coming out of the practice with sufficient expert consulting leadership is just an example of what could be solved not only the immediate lack of information about new materials in the field but also prepare people so well versed for the field so that they could help to change the passive task of the local firms to the active one.

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Pevnosť šitého spoju v ochranných odevoch

Translation of abstract:

Strength of the sewn seam of the protective clothing

Proces výroby ochranných odevov vyžaduje znalosť parametrov šitia a správny výber kombinácie spájaných materiálov. Základná mechanicko-fyzikálna kvalita tejto dvojice je pevnosť. Hľadajú sa hlavné faktory vplyvu na pevnosť švu v statickom stave. Použité materially, parameter šitia a spôsob napätia sa zohľadňujú v analýze. Práca sa týka stanovenia dĺžkovej hmotnosti, počtu zákrutov, pevnosti a rozťažnosti priadze pri roztrhnutí; stanovenie maximálnej sily pri roztrhnutí švu a ochranných vložiek a analýza štruktúry ochranných vložiek ochranných odevov pre lesných pracovníkov pracujúcich s pilou.

MODIFIKÁCIA PA 6 A PA 6 VLÁKIEN FUNKČNÝMI KO(POLYMÉRMI) A VRSTEVNATÝMI SILIKÁTMI

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Polymérne kompozity predstavujú oblasť polymérnych materiálov, ktoré našli už široké uplatnenie v priemyselných oblastiach. Ich novou triedou sú nanokompozity, čo sú polyméry plnené nanočasticami. Nanokompozity preukázali lepšie vlastnosti ako čisté polyméry, napr. lepšie mechanické vlastnosti, zníženú priepustnosť plynov a horľavosť [1].

Dôležitou oblasťou spracovania vláknotvorných polymérov je úprava ich vlastností - modifikácia, ktorá môže byť fyzikálna alebo chemická. Na modifikáciu polymérov sa najčastejšie používa montmorilonit - vrstevnatý silikát, ktorý pozostáva zo silikátových S_iO_4 tetraédrov naviazaných na oktaédre hydroxidu hlinitého alebo horečnatého v rôznych pomeroch [2].

Štruktúra kompozitu závisí od charakteru zložiek (vrstevnatý silikát, organický katión a polymérna matrica) a metódy prípravy. Disperzia ílových častíc v polymérnej matrici má za následok tvorbu troch typov kompozitov:

a) fázovo separovaný mikrokompozit,
b) interkalovaná štruktúra (vkladaná, vsúvaná) nanokompozitu a
c) exfoliovaná štruktúra (oddelená, odlamovaná, odlupovaná) nanokompozitu [3, 4].

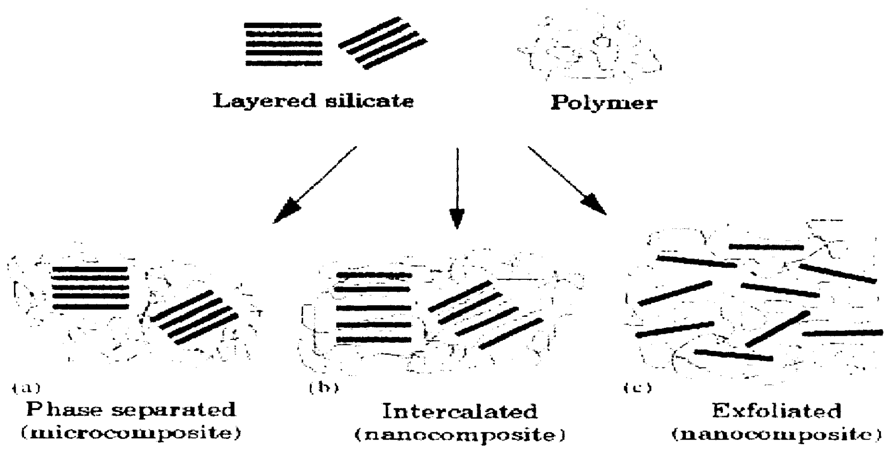
Na prípravu nanokompozitov sa používajú metódy:

- „in situ" polymerizácia [5],
- polymerizácia v emulzii [6],
- interkalácia v tavenine [7, 8],
- sol - gél proces [9].

Štruktúra a vlastnosti nanokompozitov PA 6/MMT boli charakterizované termogravimetrickou analýzou, diferenciálnou snímacou kalorimetriou, termomechanickou analýzou a testom pružnosti. Z výsledkov vychádza, že stanovené vlastnosti týchto nanokompozitov sú určené ich vnútornou štruktúrou. Nanokompozity ukázali zosilnenie ich dynamických modulov, prekonanie efektu termickej expanzie, ale aj zvýšenú ohybnosť s rastom obsahu MMT [10].

Vzájomné interakcie plnivo-matrica ako aj množstvo plniva majú vplyv na ohybnosť a tvrdosť nanokompozitov [11].

Röntgenová difrakcia (XRD), mikroskopia atómových síl (AFM), diferenciálna skanovacia kalorimetria (DSC) a ťahové skúšky sa použili na charakterizáciu mikroštruktúry, morfológie, termických a mechanických vlastností nanokompozitov PA 6/íl. Výsledky XRD a AFM ukázali, že organicky modifikované vrstevnaté silikáty sú interkalované v PA 6 matrici. Kryštalizácia



Obr. 1 Schéma rôznych typov kompozitov vyplývajúce z interakcií vrstevnatého silikátu a polyméru: a) fázovo separovaný mikrokompozit, b) interkalovaný (medzivrstvový) nanokompozit, c) exfoliovaný nanokompozit

a termické chovanie sú ovplyvnené adíciou vrstevnatého silikátu do polymérnej zmesi. Silikátom vytvorené kryštály sa transformujú z α-modifikácie na γ-kryštalickú modifikáciu [4].

Kryštalické vlastnosti nanokompozitov PA 6 s organofilným vrstevnatým silikátom boli preskúmané DSC aj XRD. Ílové doštičky v kompozite fungovali ako nukleačné činidlo a ovplyvnili kryštalickú štruktúru PA 6 a rýchlosť kryštalizácie. Stupeň kryštalinity v nanokompozite stúpa so zvyšujúcou sa rýchlosťou chladenia a nanoplnivo uprednostňuje tvorbu γ-kryštalickej modifikácie [12, 13].

Kryštalizácia a morfológia PA 6 nanokompozitov pripravených extrudovaním zmesnej taveniny závisia od typu a obsahu MMT a mólovej hmotnosti PA 6 matrice. Nukleačná schopnosť silikátových vrstiev je v týchto PA 6 nanokompozitoch malá. V mnohých zo študovaných nanokompozitov PA 6/montmorilonit fungujú dispergované silikátové vrstvy ako nečistoty a skôr znižujú ako zvyšujú kinetiku kryštalizácie PA 6 najmä pri vysokom obsahu MMT. Pri danom obsahu MMT spomalenie rastu kryštalitov rastie so zvyšujúcim sa stupňom exfoliácie (a závisí od typu MMT) i so zvyšujúcou sa mólovou hmotnosťou PA 6 [14].

Vlákna PA 6/íl boli pripravené zvlákňovaním z taveniny. Výsledky DSC meraní ukázali, že prítomnosť ílu ovplyvňuje kryštalizáciu PA 6 v γ-forme, spôsobuje zvýšenie teploty kryštalizácie a pokles teploty tavenia. Množstvo amorfných regiónov je v plnených vláknach vyšší. Plnené PA 6 vlákno sa farbí rýchlejšie ako neplnené vlákno, hlavne disperznými farbivami [15].

Zmesným tavením kopolyamidu s čiastočne aromatickou štruktúrou a vrstevnatého silikátu boli pripravené nanokompozity, ktoré majú nižšiu teplotu tavenia a zlepšené mechanické a bariérové vlastnosti v porovnaní s homopolymérom. Nanokompozity kopolyamidu s rôznym obsahom organoílu boli vyrobené dvojzávitovkovým extrúderom pri rôznych rýchlostiach vytláčania taveniny, s cieľom poukázať na vplyv rôznych podmienok spracovania na vlastnosti nanokompozitov. Silikátová nano-disperzia podstatne ovplyvňuje kryštalickú morfológiu kopolyamidovej matrice, stabilitu γ-kryštalickej fázy a dynamicko-mechanické vlastnosti zmesí [16].

Na skúmanie reologického správania sa nanokompozitov boli použité nanokompozity homopolyamidu a kopolyamidu s troma rôznymi obsahmi silikátu a rozdielne rýchlosti závitovky. Štatistický kopolymér PA 6 má čiastočne aromatickú štruktúru a ako íl bol použitý komerčný organicky modifikovaný MMT. Na hodnotenie správania sa toku nanokompozitov a ich štruktúry boli vykonané reologické experimenty kde sa menili druh matrice, obsah ílu a rýchlosť extrúzie. Merania ukázali, že účinok je výraznejší v prípade nanokompozitov na báze kopolyamidovej matrice, ktorý môže mať vyššiu afinitu k silikátu ako homopolymér PA 6 [17].

Obsah silikátu a množstvo absorbovanej vlhkosti vplýva na mechanické vlastnosti PA 6 nanokompozitov. Nanokompozity s rôznou koncentráciou silikátu absorbovali podobné množstvá vody. Modul týchto kompozitov sa zvyšuje s rastom obsahu silikátu a klesá so zvyšujúcim sa množstvom absorbovanej vlhkosti. Ťažnosť nanokompozitov klesá so zvýšeným obsahom silikátu a rastie s rastúcim obsahom vlhkosti [18].

Vplyv modifikovaného ílu v PA 6 matrici na veľkosť voľného objemu, termické a viskoelastické vlastnosti nanokompozitov bol študovaný diferenciálnou snímacou kalorimetriou a dynamicko-mechanickou analýzou. Pri nízkej koncentrácii ílového podielu v PA 6 kryštalitoch sa teplota tavenia (pôvodne 212° C) zvýšila, zatiaľ čo teplota tavenia α- kryštalitov (pôvodne blízka 222°C) sa znížila. Viskoelastické chovanie nanokompozitov PA 6/íl v porovnaní s neplneným PA 6 sa prejavuje v zmenenej pohyblivosti segmentov v nekryštalických oblastiach [19].

Degradáciu nanokompozitov PA 6/íl môžeme vyjadriť ako funkciu obsahu ílu. Nanokompozity sa môžu ľahko získať jednoduchým miešaním taveniny organicky modifikovaného ílu a polyamidu 6. Hlavnými degradačnými reakciami PA 6 sú aminolýza a/alebo acidolýza, uskutočnené cez vnútroreťazovú reakciu, produkujúcu ε-kaprolaktám, ktorý je monomérom PA 6. Ak je obsah ílu zvýšený, relatívne množstvo ε-kaprolaktámu v produkte klesá a viskozita zvyšku rozpustenej látky sa zvyšuje. Vnútroreťazové reakcie prebiehajú v prítomnosti ílu, pretože termická degradácia nastane v priestoroch galérií ílu [20].

Metódy nevariantných kinetických parametrov umožňujú modelovanie termickej degradácie, ktorá nastáva v prítomnosti kyslíka. Na zabránenie pyrolýzy a termooxidačnej degradácie nanokompozitov sa používajú účinné samoochranné filmy [21].

Viaczložkové polymérne materiály sú často pripravené tavením 2 alebo viac miešateľných alebo nemiešateľných polymérov. Tento jednoduchý spôsob nie je najvhodnejší na získanie dobrej disperzie polymérnych zmesí, hlavne pri kombinácii polárnych a nepolárnych polymérov. V dôsledku rôznych polarít zložiek vznikne heterogénny systém s dvoma fázami, jeden polymér je rozdispergovaný v druhom, pričom tvar a rozmer ich častíc závisí od niekoľkých faktorov, ako je viskozita taveniny zložiek, medzifázové napätie a adhézia, podmienky spracovania a iné. Konečné vlastnosti týchto zmesí sú silno ovplyvnené objemovým zlomkom obidvoch zložiek, rozmerom a tvarom ich častíc a medzifázovým napätím i adhéziou medzi dvoma fázami [22].

Cieľom zmesí PA 6 a PP bolo zlepšenie mechanických a bariérových vlastností i natierateľnosti, pričom PA 6 prispeje k zlepšeniu mechanických a termických vlastností a PP zabezpečí dobrú spracovateľnosť a necitlivosť na vlhkosť. Zmiešanie PA 6 a PP je veľmi náročné. Polyméry sú nemiešateľné a vytvoria heterogénny systém, ktorý má slabé mechanické vlastnosti. Na zníženie medzifázového napätia a na zlepšenie adhézie medzi dvoma zložkami sa používajú kompatibilizačné prísady. Pre zmesi PA 6 a PP sa najčastejšie používajú polypropylén očkovaným maleínovou alebo akrylovou kyselinou. Vlastnosti zmesi PA 6/PP závisia od ich pomeru, objemového zlomku, zloženia a funkčnosti kompatibilizátora, mólovej hmotnosti PA a PP a kryštalickej štruktúry systému [23].

Pevnosť a tvrdosť PA 6/ PP nanokompozitov boli významne zlepšené použitím kompatibilizátora PP očkovaného maleinanhydridom (MAH-g-PP), ktorý zlepšuje znášanlivosť PA 6, PP a organoílu [24].

PP a PA 6 zliatinové nanokompozity boli pripravené interkaláciou v tavenine zmiešaním PP a PA 6 pri použití organofilného MMT. Pri interkalácii bol použitý kompatibilizátor MAH-g-PP. Štruktúry nanokompozitov boli charakterizované snímacou elektrónovou mikroskopiou, X-lúčovou difrakciou a transmisnou elektrónovou mikroskopiou. Bolo zistené, že zloženie zmesi má vplyv na dispergáciu organofilného MMT a vybudovanú kryštalickú štruktúru a vyššia rýchlosť kryštalizácie má za následok zvýšenie γ-kryštalickej fázy [25].

Mechanické vlastnosti nanokompozitných materiálov veľmi závisia od spôsobu ich prípravy a od spôsobu úpravy a obsahu plniva. Úprava plniva a lepšia kompatibilita má pozitívny vplyv na celý systém. V prípade PA 6 nanokompozitov hodnoty modulov a napätia v ťahu sú v porovnaní s nemodifikovaným PA 6 vyššie [26].

„In situ" postupom pripravené PA 6 vlákna s obsahom rôzne upraveného plniva [27, 28] vykazujú zvýšenie napätia v ťahu, čo je často spôsobené prítomnosťou polárnych skupín a iónových interakcií medzi polymérnou matricou a silikátovými vrstvami.

Nanokompozity s exfoliovanou štruktúrou vykazujú prudké zvýšenie Youngovho modulu aj pri nízkom obsahu plniva. Pevnosť materiálu sa zvyšuje polymerizáciou v prítpmnosti organicky modifikovaného MMT, MMT napučaného s protonizovaným ε-kaprolaktámom (ε-KL) alebo s prírodným MMT v prítomnosti ε-KL a kyslého katalyzátora. Schopnosť dispergovaných častíc zvyšovať Youngov modul nanokompozitov PA 6 môže závisieť od priemernej dĺžky vrstiev dispergovaných častíc. Exfoliovaná štruktúra a Youngov modul sa s obsahom ílu zvyšuje, ale pri určitom obsahu ílu (10 % hm.) štruktúra nanokompozitu je len čiastočne exfoliovaná a Youngov modul klesá. Exfoliované vrstvy sú hlavným faktorom ovplyvňujúcim pevnosť kompozitu a interkalované častice majú na pevnosť len nepatrný vplyv [29].

Burmistra [30] skúmal vplyv vrstevnatého silikátu modifikovaného polymérnymi kvartérnymi amóniovými iónmi (organofilný Bentonit) na mechanické vlastnosti nanokompozitov lineárnych polymérov a Bentonitu. Pevnosť čistého PA 6 je 31 MPa, ale s obsahom 1 % hm. bentonitu sa zvýšila na 46 MPa. Adíciou 2 % hm. bentonitu do polyamidu stúpa pevnosť nanokompozitu až o 53 %.

Stuženie nanokompozitov PA 6/organicky modifikovaný MMT bolo realizované ich miešaním s 3 - 40 % hm. maleinizovaného styrén-etylén/butadién-styrén kopolymérom (mSEBS). Nanoštruktúra PA 6 matrice, ani podstata dvoch polymérnych fáz pri adícii organofilného MMT sa nemenila pri jej miešaní s mSEBS. Morfológia častíc kaučuku v nanokompozite bola homogénna s väčším počtom častíc. Získaný nanokompozit mal menšiu ťažnosť pri deformácii, ale bolo možné pripraviť aj superpevné nanokompozity s 30 % hm. obsahom mSEBS [31].

Nanokompozity PA 6/íl spevnené uhlíkovým alebo skleneným vláknom majú v dôsledku silných interakčných síl medzi PA 6 matricou a ílom zlepšené mechanické vlastnosti (ťažnosť, pevnosť v ohybe, moduly, atď.) a termické vlastnosti, [32].

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Súhrny diplomových prác na Katedre textilu a odevníctva, FPT TnU so sídlom v Púchove v rámci inžinierskeho štúdia v školskom roku 2006/2007

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FARBENIE PRÍRODNÝCH MATERIÁLOV PRÍRODNÝMI FARBIVAMI A ICH FIXÁCIA.

Práca nadväzuje na výsledky diplomovej práce z roku 2006. Riešilo sa farbenie prírodných materiálov prírodnými farbivami z rastlín *Carthamus tinctorius L.* a ich fixácia. Overil sa obsah farbív v štyroch rôznych vzorkách po ročnom skladovaní sušených okvetných lístkov *Carthamus Tinctoriius L.* (CT). Uvedenými prírodnými farbivami z rastlín CT je možné získať žlté a červené vyfarbenia, v závislosti od pH farbiaceho kúpeľa. U vyfarbených vzoriek bavlny, ľanu a prírodného hodvábu sa testovala a hodnotila stálofarebnosť na svetle, v domácom a komerčnom praní a vo vode. Najlepšie stálofarebnosti sa získali na prírodnom hodvábe.

DYEING NATURAL MATERIALS WITH NATURAL DYES AND THEIR FIXATION

The work follows the results of a thesis from 2006. The main point was the dyeing of natural materials with natural dyes from Carthamus tinctorius L. (CT) plants and their fixation. The content of the dyes was verified on four different samples of the dried petals of CT, which were stored for one year. Through use of the natural dyes, it is possible to get yellow and red coloration depending on the pH of the dyeing bath. The colour stability of the coloured samples of cotton, linen and natural silk was tested under exposure to sun, colour stability in domestic and commercial washing, and also water. The best colour stability was obtained on the natural silk.

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SLEDOVANIE VPLYVU MATERIÁLOVÉHO ZLOŽENIA A KONŠTRUKCIE NETKANÝCH TEXTÍLIÍ NA ICH ELEKTROVODIVÉ VLASTNOSTI.

Diplomová práca sa zaoberá analýzou a sledovaním vplyvu materiálového zloženia a konštrukcie netkaných textílií na ich elektrovodivé vlastnosti. V práci je uvedený postup prípravy netkaných textílií, výsledky hodnotenia a metodiky hodnotenia elektrovodivých vlastností a zakladných fyzikálno-mechanických vlastností spolu s popisom použitých metodík.

STUDY OF THE EFFECT OF THE MATERIAL COMPOSITION AND CONSTRUCTION OF NON-WOVEN TEXTILES ON THEIR ELECTRO-CONDUCTIVE PROPERTIES.

The thesis deals with the analysis and observation of the effect of the material composition and construction of non-woven textilies on their electro-conductive properties.

In the experimental part the progressive arrangements of non-woven textiles is mentioned, along with the result ratings and methodology ratings of the electro-conductive properties and basic physical-mechanical properties along with a description of methodology used.

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VPLYV PODMIENOK NA VÝSLEDKY MERANIA FYZIOLOGICKÝCH PARAMETROV NA PRÍSTROJI PERMETEST.

Diplomová práca sa zaoberá vplyvom klimatických podmienok na fyziologické parametre. Merala sa tepelná odolnosť, odolnosť voči vodným parám a paropriepustnosť na pristroji Permetest. Okrem toho sa sledoval vplyv teploty a relatívnej vlhkosti vzduchu na uvedené hodnoty. Zistilo sa, že zvolené klimatické podmienky nemajú významný vplyv na výsledky merania fyziologických parametrov, pretože z grafických závislostí nie je viditeľná žiadna lineárna závislosť. Za tohto predpokladu boli namerané hodnoty vyhodnotené štatisticky, kde variabilita meraní sa zdá ako následok konštrukcie textílií: rovnomernosť a kvalita nánosu, rovnomernosť membrány alebo rovnomernosť vlákennej výplne.

CONDUCTION EFFECT ON THE RESULTS OF MEASUREMENTS OF PHYSIOLOGICAL PARAMETERS ON PERMETEST EQUIPMENT.

The thesis is about the effect of climatic conditions on the results of measurements of physiological parameters. Thermal endurance, water vapour resistance and water vapour permeability were measured on the Permetest. It was found that the given climatic conditions do not have a prominent effect on the results of measurements of physiological parameters, because linear dependence is not visible from graphic dependences. For this assumption the results of measuring were processed statistically, where the variability measurements seem to affect the textile's construction: its uniformity and quality deposit uniformity of microfibrils filling.

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ŠTÚDIUM A ANALÝZY PEVNOSTI ŠVA PRI ŠITÍ AUTOPOŤAHOV A ZABEZPEČENIE SPOĽAHLIVOSTI STEHOTVORNÝCH ORGÁNOV

Diplomová práca sa zaoberá analýzou a stanovením pevnosti šva a strojných zariadení pri šití airbagových a autopoťahových švov. Pripravené vzorky sú charakteristické rôznymi spôsobmi štepovania (švy bez štepovania, švy raz štepované a švy dvakrát štepované); rôznymi farbami materiálu (Latte Mancchiato, Black, Classig Grey) a rôznymi hrúbkami materiálu (1 mm, 3 mm, 4,5 mm). Vzorky boli skúšané podľa prislušných noriem.

Vzorky švov a nití používané pri šití autopoťahov vykazovali vysoké pevnosti okrem spodných airbagových šijacích nití, ktoré musia mať nižšiu pevnosť, aby sa pri náraze švy pretrhli a vzduchový vak nafúkol. Porovnávali sa nite montážne a nite na štepovanie. Štepovacie nite majú väčšie pevnosti ako montážne nite.

STUDY AND ANALYSIS OF THE FORTRESS STITCH WHEN SEWING CAR COVERS AND ASSURING THE SAFETY OF STITCH-FORMING ORGANS

The thesis deals with the analysis and evaluation of seam strength and machinery at sewing of airbag and car upholstery seams.Samples prepared are characterized by differend ingraft way (stich without ingraft, once ingraft and twice ingraft), different colour of material (Latte Mancchiato, Black, Classig Grey) and different thickness of material (1 mm, 3 mm, 4.5 mm). Samples were tested by corresponding normalized standards. Samples of seams and threads used for sewing of car upholstery exhibit high tensile strength besides botton airbag sewing threads, which have to have lower tensile strength becouse they have to split to assure the airbag inflation. Sewing and ingraft threads were composed. Ingraft threads have higher strength than sewing ones.

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PRÍPRAVA OKTENYLSUKCINÁTOV KARBOXYMETYL ŠKROBU ÚČINKOM MIKROVLNNÉHO ŽIARENIA A ŠTÚDIUM ICH VLASTNOSTÍ

Diplomová práca sa zaoberá prípravou oktenylsukcinátov CMŠ esterifikáciou oktenylsukcín anhydridom v prostredí dimetylsulfoxid/kyselina p-toluénsulfónová (DMSO/pTSA) alebo bez pTSA zmenou reakčných podmienok (času, mólového pomeru) účinkom mikrovlnného žiarenia, alebo pôsobením ultrazvuku. Pripravené deriváty sa charakterizovali FT-IR spektroskopiou. Hodnotili sa povrchovo-aktívne a funkčné vlastnosti (povrchové napätie, kritická micelárna koncentrácia, emulgačná účinnosť, pracia a antiredepozičná účinnosť). Pripravené derivaty boli rozpustné vo vode, vykazovali dobré emulgačné účinnosti porovnateľné so štandardným emulgátorom Tween 20 a mali veľmi dobrú praciu a antiredepozičnú účinnosť.

PREPARATION OF CARBOXYMETHYL STARCH OCTENYLSUCCINATES BY MICROWAVE IRRADIATION AND STUDY OF THEIR PROPERTIES

The thesis deals with the preparation of carboxymethyl starch octenylsuccinates by esterification with octenylsuccinic anhydride in a dimethylsulfoxide/p-toluenesulfonic acid (DMSO/pTSA) system under various reactive conditions (time, molar ratio) by microwave irradiation or ultrasound. The derivatives were characterised by means of FT-IR spectroscopy. The surface-active and functional properties (surface tension, critical micelle concentration, emulsifying efficiency, washing power and antiredepositive efficiency) were estimated. The prepared derivates were water-soluble, showed good emulsifying efficiency, comparable with commercial standard Tween 20, and had excellent washing power and antiredepositive efficiency.

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ŠTÚDIUM A ANALÝZA MECHANICKÝCH VLASTNOSTÍ ŠITÝCH SPOJOV V TECHNICKEJ KONFEKCII.

Diplomová práca sa zaoberá analýzou a stanovením mechanických charakteristík šijacích nití, švov a ochranných vložiek používaných pri šití ochranných odevov pre používateľov ručných reťazových píl. Úlohou diplomovej práce bolo stanovenie dĺžkovej hmotnosti, počtu zákrutov, pevnosti a ťažnosti šijacích nití pri pretrhnutí. K dispozícii bolo šesť polyesterových nití, jedna meta-aramidová niť a jedna zmes bavlna/polyester. Tiež sa stanovila maximálna sila pri pretrhnutí šva a ochranných vložiek a analýza zloženia ochranných vložiek. Na základe dosiahnutých výsledkov je možné odporučiť na zhotovenie nosných švov výrobkov nite Reutex 80, Alterfil 80 a Amann 80, 75 a 70 a 6-vrstvovú ochrannú vložku.

STUDIES AND ANALYSIS OF THE MECHANICAL PROPERTIES OF A SEWING SEAM IN A TECHNICAL COMPOSITION

The aim of the thesis is to analyse and state the mechanical characteristics of sewing threads, seams and protective support in the case of sewing protective wears when using hand chain saws. The task of the thesis was determining the fineness, number of windings per meter, and strength and tensile strength of sewing threads during breakage. Six polyester threads, one meta-aramide thread and one cotton/polyester compound were available. The next task was to determine the maximal force in the case of the rupture of seams and protective support and then analyse their composition. The results achieved recommended Reutex 80, Alterfil 80 and Amann 80, 75 and 70 and 6-layers threads as protective support for making the main seams of products.

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ADITIVOVANIE NANOSÓLOV PRE POVRCHOVÚ ÚPRAVU TUHÝCH POVRCHOV

Táto diplomová práca sa zaoberá povrstvením netkaných textílií, používaných ako filtračný materiál, sól - gél postupom. Úprava spočívala v nánose dvoch vrstiev. Prvým nánosom sa naniesla vrstva oxidu kremičitého (práškovaním tuhým SiO2 alebo nanesením disperzie SiO_2 aplikovanej ponorom) a druhý nános bol funkčne cielený s výsledným hydrofóbnym (sól K3 alebo prípravok SOGETEC 047) alebo hydrofilným (prípravok Magnasoft Prime) efektom. Experimenty ukázali, že povrstvenie SiO_2 z disperzie je rovnomernejšie, funkčné prevrstvenie vykazovalo hydrofóbny, resp. hydrofilný charakter.

ADDITIVATION OF NANOSOLS FOR SURFACE TREATMENT OF SOLID SURFACES

This thesis deals with coating nonwoven textiles used as filter material by the sol - gel process. The treatment consisted of two layers. As the first layer, silica dioxide was applied, either by powdering solid SiO2 or dipping in a SiO2 dispersion. The second layer was functionally aimed at achieving a hydrophobic (sol K3 or SOGETEC 047 preparation) or hydrophilic (preparation Magnasoft Prime) effect. The experiments showed that coating with SiO2 from a dispersion is more even; the second layer showed a hydrophobic or hydrophilic character.

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ŠTRUKTÚRA A VLASTNOSTI VLÁKIEN Z RÝCHLORASTÚCICH BAMBUSOVÝCH SUROVÍN

Diplomová práca je zameraná na hodnotenie štruktúry a vlastností bambusových vlákien, vláknitých materiálov a výrobkov zo zmesi bambusových a bavlnených vlákien.

Z fyziologických vlastností sa u vlákien zisťoval obsah vlhkosti. Hodnotila sa makromorfologická štruktúra (priečny rez a pozdĺžny pohľad). Pri hodnotení fyzikálno-mechanických vlastností vláknitých materiálov sa u priadzí hodnotila pevnosť, ťažnosť, Youngov modul a koeficient trenia. Fyziologické a fyzikálne vlastnosti tkanín a pletenín boli priaznivé. Porovnali sa tiež vlastnosti bambusových, bavlnených a viskózových vlákien.

STRUCTURE AND PROPERTIES OF FIBRES FROM RAPID - GROWING BAMBOO MATERIALS

The purpose of this work is an evaluation of the structure and properties of bamboo fibres, fibre materials and products, which are made from a mixture of bamboo and cotton fibres.

The macromorphological structure was evaluated from cross cut and lengthwise views. The physico- mechanical properties were determined by measuring the tensile strength, elongation, Young's modulus and frictional coefficient. The physiological and physical properties of the fabrics and knitwear were favourable. One of the aims of the work was a comparison of the established properties of bamboo and cotton fibres.

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Recenzent: Ing. Iveta Mlynárová

PRÍPRAVA, ŠTRUKTÚRA A VLASTNOSTI PONOŽIEK NA BÁZE MODIFIKOVANÝCH PP VLÁKIEN S RÔZNOU GEOMETRIOU

Diplomová práca je zameraná na prípravu a hodnotenie vlastností pletenín a ponožiek s rozdielnym materiálovým zložením a s rôznou jednotkovou jemnosťou použitých vlákien. Kombinovali sa polypropylénové vlákna s bavlnenými a bambusovými vláknami. Hodnotila sa makromorfologická štruktúra, fyzikálno - mechanické, fyziologické a úžitkové vlastnosti. Bambusové vlákna majú niektoré vlastnosti rozdielne v porovnaní s bavlnenými a viskózovými vláknami. Bambus obsahuje antimikrobiálne a bakteriostatické látky. Účinky týchto látok sa zachovajú aj počas viacerých procesov spracovania. Zo získaných výsledkov vyplýva , že použitím bambusových vlákien v kombinácii s PP vláknami sa dajú zvýšiť úžitkové vlastnosti textilných materiálov v porovnaní s kombináciou ba/PP.

PREPARATION, STRUCTURE AND PROPERTIES OF SOCKS ON A MODIFIED POLYPROPYLENE FIBRE BASE WITH VARIOUS GEOMETRIES

The thesis specialized in the preparation and evaluation of the properties of knitted fabric and socks with various material compositions and with various fineness of the fibers used. We used a combination of polypropylene fibers with cotton and bamboo fibers. The macromorphological structure, physical - mechanical, physiological properties and utilitarian properties were evaluated. Bamboo fibers have some different properties when compared to the properties of cotton or viscose fibers. Bamboo includes an antimicrobial and bacteriostatic substance. The effect of these substances during many processing was preserved. The results obtained show that the application of bamboo fibers with PP fibers can increase the end-use properties of textile materials compared to cotton with PP.

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Konzultant DP: Ing. Zuzana Jakubíková
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PRÍPRAVA ZMESI LDPE S BIOPOLYMÉRMI ZA PRÍTOMNOSTI KOMPATIBILIZÁTORA A ŠTÚDIUM ICH VLASTNOSTÍ

Diplomová práca sa zaoberá prípravou zmesí nízkohustotného polyetylénu a karboxymetylškrobu s DS = 0,3 v štyroch rozdielnych množstvách (5, 10, 15 a 20 hm.%) za a bez prítomnosti kompatibilizátora (kopolymér etylénu a kyseliny akrylovej (EAA) v rozdielnych množstvách. Pripravené zmesi sa charakterizovali FTIR spektroskopiou a termogravimetrickou analýzou (TGA). Študovali sa tiež ich mechanické vlastnosti, ako sú pevnosť v ťahu, ťažnosť, Youngov modul a pevnosť na medzi klzu. Najlepšie mechanické vlastnosti vykazovali zmesi obsahujúce 5 a 10 hm.% CMS a 50 hm.% EAA. Zmesi sa vyznačovali dobrými termickými vlastnosťami.

PREPARATION OF LDPE/BIOPOLYMER BLENDS CONTAINING A COMPATIBILIZER AND STUDY OF THEIR PROPERTIES

The thesis deals with preparation of blends of low-density polyethylene and carboxymethylstarch with DS = 0.3 in four different amounts (5, 10, 15 and 20 wt.%) with and without a compatibilizer. Poly(ethylene-co-acrylic) acid (EAA) copolymer was used as a compatibilizer in three different amounts. The prepared blends were characterized by FTIR spectroscopic methods and thermogravimetric analysis (TGA). The mechanical properties such as tensile strength, elongation and Young`s Modulus were studied. The blends containing 5 and 10 wt.% CMS and 50 wt.% EAA indicated the best mechanical properties. They also had good thermal properties.

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OPTIMALIZÁCIA NAPÄTIA OSNOVNÝCH NITÍ TKACÍCH STROJOV PICANOL GAMA PRE JEDNOTLIVÉ DEZÉNY

Cieľom diplomovej práce bolo optimalizovať napätie osnovných nití na tkacích strojoch Picanol Gama pre jednotlivé dezény.

Sledoval sa vplyv znižujúceho nastaveného napätia na tkacom stroji na rozdielne napätie osnovy v krajoch osnovy od stredu, kvalitu tkania, kvalitu tkaniny a na pevnosť a ťažnosť surovej a upravenej tkaniny.

So znižovaním nastaveného napätia na tkacom stroji sa znižoval rozdiel napätia osnovy v krajoch od stredu, nemenila sa pevnosť hotovej tkaniny a predpoklad vzrastu ťažnosti hotovej tkaniny sa nepotvrdil.

OPTIMALIZATION OF TENSION WARP THREADS AND PICANOL GAMA SWIVEL MACHINE FOR A SINGLE DESIGN

The influence of decreased given tension of swivel macine on the tension from centre to the border of the warp as well as on the quality of weaving, quality of fabric and tensile strength elongation of raw and processed fabric. Decreased tension of swivel machine caused a lower difference of warp tension at the border and did not influence the tensile strength of prepared fabric. The assumption of increased elongation was not confirmed.

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PRÍPRAVA, ŠTRUKTÚRA A VLASTNOSTI BYTOVÝCH VLÁKNITÝCH MATERIÁLOV Z MIKROPOLYESTEROVÝCH VLÁKIEN

Diplomová práca je zameraná na prípravu vláknitých materiálov (rún) s rôznym zložením polyesterových vlákien a ich zmesí. Rúna boli pripravené z troch typov polyesterových vlákien s rôznou dĺžkovou hmotnosťou a rôznym zložením.

Pripravené rúna boli hodnotené z hľadiska ich fyzikálno mechanických vlastností (dĺžková hmotnosť, pevnosť (priemerná a pomerná), ťažnosť (priemerná), Youngov modul a príjem vlhkosti), makromorfologickej štruktúry (počet vlákien), deformačných vlastností a úžitkových vlastností.

V závere sa posudzovali vzťahy podmienok prípravy, materiálového zloženia, štruktúry a vlastnosti rún.

STRUCTURE AND PROPERTIES OF FIBROUS MATERIALS MADE FROM MICROPOLYESTER FIBRES

The thesis is focused on the preparation of fibrous materials (fleeces) with various compositions of fibrous polyesters and their combinations.

The fleeces were prepared from three types of polyesters fibres with various fineness and compositions.

The prepared fleeces were evaluated from the aspect of their physico - mechanical properties (fineness, tensile strength (average and relative), elongation, Young's modulus and humidity), macromorphological structure (number of fibers), deformation properties and end-use properties.

Correlation of the preparation conditions, material compositions, textures and properties of the fleeces were considered.

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Recenzent: Ing. Gabriela Závodská

VPLYV PODMIENOK KONTINUÁLNEJ A DISKONTINUÁLNEJ PRÍPRAVY PET VLÁKIEN NA ICH ŠTRUKTÚRU A VLASTNOSTI

Táto diplomová práca je zameraná na hodnotenie štruktúry a vlastností polyetyléntereftalátových (PET) vysokopevných technických (seglových) vlákien pripravených kontinuálnym a diskontinuálnym výrobným procesom.

PET vlákna sa pripravili na prevádzkovom zariadení v spoločnosti Slovkord a.s. Granulovaný polymér použitý na prípravu vlákien s limitným viskozitným číslom (Lvč) 99 - 110 ml/g. bol spracovaný dopolykondenzáciou v tuhej fáze.

Hodnotenie štruktúry vlákien bolo orientované na parametre nadmolekulovej a morfologickej štruktúry. Hodnotenia úžitkových vlastností PET vlákien bolo zamerané na základné fyzikálno-mechanické parametre.

EFFECT OF CONTINUOUS AND DISCONTINUOUS CONDITIONS ON THE PREPARATION OF PET FIBRES AND THEIR STRUCTURE AND PROPERTIES

The thesis focuses on an evaluation of the structure and properties of polyethylenetherephthalate (PET) high tenacity technical segle fibres prepared using continuous and discontinuous production processes.

The preparation of the PET fibers was carried out on technical equipment at the Slovkord a.s. company. Granulated polymer, which was used for preparation of the fibres with an intrinsic viscosity value (i.V.) of 0.99-1.10 dm/g was processed using complete condensation in a solid phase.

The evaluation of the fibre structure was oriented towards the parametres of the supra-molecular and morphological structures. The evaluation of the properties of the polytheneterephtalate (PET) fibres focused on the main physical and mechanical properties.

The thesis includes the conditions and correlations of the preparation, structure and properties of polytheneterephtalate (PET) fibres. The measured values and correlations are presented in tables and graphic charts.

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ŠTÚDIUM VYUŽITIA NÁSTROJOV A METÓD PRE ZLEPŠOVANIE KVALITY VO FIRME

Diplomová práca je zameraná na proces riadenia kvality analyzovanej firmy Makyta a.s. Púchov. Obsahuje prehľad poznatkov z oblasti kvality a jej riadenia, systému manažérstva kvality, noriem ISO radu 9000, procesného prístupu, ľudského faktora, metód a nástrojov používaných na zabezpečenie kvality. Praktická časť obsahuje analýzu riadenia a kontroly kvality, výrobného procesu rozdeleného na jednotlivé výrobné etapy (predvýrobnú, výrobnú a povýrobnú) s pohľadu riadenia a kontroly kvality a používaných nástrojov a metód zabezpečovania kvality. Navrhnuté opatrenia na zlepšenie nedostatkov - vypracovanie pracovných postupov, zavedenie monitorovania výrobných zariadení a zabezpečenia dostatočného vzdelávania výrobných pracovníkov, majstrov a pracovníkov technickej kontroly a využívanie nástrojov a metód zabezpečovania kvality.

ANALYSIS OF THE IMPLEMENTS AND METHODS FOR IMPROVING QUALITY IN A COMPANY

The thesis is oriented towards the quality management process of the analyzed company, Makyta a.s. Púchov. It includes a summary of the results about the quality management system, the ISO system file 9000, the process approach, the human factors, implements and methods used for the quality assurance. A practical section includes an analysis of the management and quality control, the operating processes divided into individual production stages (before, during and after production) from the view point of management and control quality and the implements and methods for quality assurance used. The suggested arrangements for improvement contains documented operating procedures, an application for the monitoring of the production equipment and the provision of continuing education.Education is necessary for all the operators and using implements and methods for providing quality.

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ŠTÚDIUM A ANALÝZA MECHANICKÝCH VLASTNOSTÍ ŠIJACÍCH NITÍ V SPOJOVACOM PROCESE

Diplomová práca sa zaoberá vplyvom predpätia šijacích nití v procese šitia, šitého materiálu a otáčok stroja na šijaciu schopnosť nite, zmenu jej mechanicko-fyzikálnych vlastností v podmienkach výroby. Výsledkom bolo zistenie, že pre tvorbu kvalitného stehu je potrebné diferencovať nastavenie predpätia vrchnej a spodnej šijacej nite. Sledoval sa optimálny pracovný režim šijacieho stroja DÜRKOPP ADLER 272. Boli potvrdené zmeny fyzikálno - mechanických vlastnosti šijacích nití po šití v závislosti od vybraných parametrov šijacieho stroja a použitého odevného materiálu.

STUDY AND ANALYSIS OF THE MECHANICAL PROPERTIES OF SEWING THREADS IN THE JOINING PROCESS.

The thesis deals with the effect of prestressing sewing threads in the sewing process, the material being sewn and the revolution of the sewing machine on the sewing properties of the thread - the change in its mechanico-physical properties in industrial production conditions. As a result it was determined that for the production of a quality stitch, it is necessary to differentiate the adjusting of the prestressing of the upper and lower sewing thread. The optimal working regime of the DÜRKOPP ADLER 272sewing machine was monitored. The changes in the physical-mechanical properties of the sewing threads after sewing, which depend upon the chosen parameters of the sewing machine and textile material used, were proved.

Ingrid Kakodyová
Vedúci DP: Ing. Anna Lovászová
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Recenzent: Ing. Renáta Polláková

ÚPRAVA pH HODNOTY BA TKANÍN

V diplomovej práci sa riešila úprava pH hodnôt ba tkanín rôznymi neutralizačnými prostriedkami pre potreby a.s. Levitex. Na úpravu pH hodnôt ba tkanín sa použili štyri rôzne neutralizačné prostriedky.

Najlepšie výsledky sa získali použitím neutralizačného prostriedku NEUTRACID NVM 200 s kombináciou TPP, ktorý spĺňa požiadavku OEKO - TEX STANDARD 100.

Najhoršie výsledky vo všetkých stupňoch merania sa dosiahli pri použití kys. octovej kombináciou s TPP. Jej použitím sa objavujú po vysušení upravených tkanín, alkalické zvyšky u vyfarbených a vybielených vzoriek.

Riešenie úprav pH hodnôt ba tkanín má humánno-ekologický význam pre Levitex, a.s.

MODIFICATION AND PH LEVEL OF COTTON TEXTILES

The modification of the pH level of cotton textiles by using different agents for the needs of the JOINT STOCK COMPANY LEVITEX is the main topic of the thesis.

Four different neutralization agents for the modification of the pH level of the cotton textiles were used.

The best results were obtained by using the NEUTRACID NVM 200 neutralization agent with a combination of the TPP-textile advisory agent, which discharged the imposition of OEKO-TEX STANDARD 100.

On the contrary, the worst results were achieved by using an acetic acid with a combination of TPP in every level of the measurement because the alkaline remnant on the coloured and bleached pieces appeared after the dehydration of the modified textiles.

The resolution of the modification of the pH levels of the cotton textiles has humane-ecological importance for LEVITEX company.

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Recenzent: Ing. Libuša Kováčiková

RACIONALIZÁCIA TECHNOLOGICKEJ PRÍPRAVY VÝROBY V TECHNICKEJ KONFEKCII

Diplomová práca je zameraná na technologickú prípravu výroby technickej konfekcie v podmienkach výrobného družstva VZOR, Zvolen. Nachádza sa v nej prehľad poznatkov z oblasti technickej prípravy výroby a je charakterizovaná technologická dokumentácia. Zároveň opisuje uplatnenie automatizácie a výpočtovej techniky pri racionalizácii práce v technickej príprave výroby. Obsahuje tiež charakteristiku ochranných odevov pre používateľov ručných reťazových píl, ktorých technologická dokumentácia sa v práci analyzuje. Navrhnuté opatrenia v technologickej dokumentácii sú: zmena štruktúry technického opisu, doplnenie databanky informačného systému firmy obrázkovou dokumentáciou a používanie odbornej terminológie.

RATIONALIZATION OF THE TECHNOLOGICAL PREPARATION OF PRODUCTION IN A TECHNICAL CONFECTION

The thesis is focused on the technical preparation of the production of a technical confection in the conditions of the VZOR cooperative in Zvolen. The thesis includes a summary of the knowledge from the area of the technical preparation of the production and is characterized by technical documentation. Simultaneously, it describes the use of automation and information technology by the rationalization of the work in the preparation of the production. Also includes the characteristic of the protective clothing used by the portable chain saw workers; that technological documentation is analyzed in the work. Proposed measures include: a technical description of the bill of exchange structure, updating the company's information system database's pictorial documentation and the application of specialized terminology.

Katarína Morvaiová
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Konzultant DP: Ing. Viktor Tatár
Recenzent: Ing. Eva Janišová

RACIONALIZÁCIA KONŠTRUKČNEJ PRÍPRAVY VÝROBY NA PRÍKLADE DÁMSKEJ ODEVNEJ KONFEKCIE

Diplomová práca sa zaoberá racionalizáciou konštrukčnej prípravy výroby dámskej konfekcie pomocou počítačom podporovaných pracovísk. Analýzou konštrukčných metodík (nový veľkostný systém (NVS), jednotná metodika konštruovania odevov (JMKO), Műller&Shon (M&S), Parafianowicz) sa zistilo, že pre realizáciu strihových súčastí dámskeho saka je vhodná metodika NVS a pre dámske nohavice metodika M&S. Zhotovili sa súčasti konštrukčnej dokumentácie, t.j. technické nákresy, základné strihové konštrukcie a vymodelované strihy, progresívnou technikou - systémom CAD. Snímkovali sa modelárske operácie vykonávané manuálne a systémom CAD. Analýzou uvedených operácií sa zistila miera zníženia spotreby času. Následné ekonomické hodnotenie potvrdilo, že investícia, umožňujúca modelovanie systémom CAD z hľadiska doby návratnosti je akceptovateľná.

RATIONALIZATION OF THE CONSTRUCTIONAL PREPARATION OF PRODUCTION USING THE EXAMPLE OF LADIES' CLOTHING

This thesis investigated the rationalization of the contructional preparation of the production of ladies' clothing with the help of workplaces with computer suppport. By using an analytic methodology of the types - New Size System (NSS), Uniform Construction Methodology of Clothing (UCMC), Műller&Shon (M&S), and Parafianowicz, it was determined that for realizing the cut part of a ladies' blazer, the proper methodology is NSS and for ladies' trousers, the methodology is M&S. The documentation of the cut parts construction (the technical drawings, the basic cuts and the final shaping cuts) were finished off with a CAD system. Shaping operations using a manual cut and operations using the CAD system were time measured. A measure meant for reducing the time needed was determined by an analysis of the above-mentioned operations. The final evaluation confirmed that an investment the CAD systems for shaping is acceptable from the standpoint of the return of capital.

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Konzultant DP: Ing. Zuzana Jakubíková
Recenzent: Ing. Zdenka Hromádková, PhD.

AMIDÁCIA CMŠ S RÔZNYMI ALKYLAMÍNMI A ŠTÚDIUM VLASTNOSTÍ PRIPRAVENÝCH BIOPOLYMÉROV

Diplomová práca sa zaoberá štúdiom povrchovo-aktívnych a funkčných vlastností derivátov pripravených amidáciou O-(karboxymetyl)škrobu .

Deriváty sa pripravili amidáciou v prostredí metanolu a DMSO, za prítomnosti dimetylaminopyridínu ako katalyzátora zmenou reakčných podmienok (teploty, času, hmotnostného a mólového pomeru) pri klasickom spôsobe ohrevu, kde ako modifikátor bol použitý dodecylamín,hexylamín a decylamín Pripravené deriváty sa charakterizovali FT-IR spektrami a u vodorozpustných sa stanovila emulgačná účinnosť, povrchové napätie, kritická micelárna koncentrácia, pracia a antiredepozičná účinnosť.

AMIDATION OF O-(CARBOXYMETHYL) STARCH WITH VARIOUSLY ALKYLAMINES AND ANALYSIS OF THE PROPERTIES OF PREPARED BIOPOLYMERS

The thesis deals with an analysis of the surface-active and functional properties of derivates prepared by the amidation of O-(carboxymethyl) starch. The derivates were prepared by amidation in a solvent system of methanol and DMSO, with DMAP as a catalyst. The reactions were carried out under various reaction conditions (mass or mole ratio, time, temperature) with conventional heating. As modifiers dodecylamine, hexylamine and decylamine were applied.

The prepared derivates were characterized by FT-IR spectroscopy and the surface-active properties such as emulsifying efficiency, washing power, antiredeposition efficiency and the surface tension of water-soluble derivates were determined.

Adriana Pontešová
Vedúci DP: Prof. Ing. Martin Jambrich, DrSc.
Konzultant DP: Ing. Mikuláš Kišš
Recenzent: Ing. Danica Červinková

PRÍPRAVA A VLASTNOSTI KOMPOZITOV NA BÁZE POLYPROPYLÉNU A ČADIČOVÝCH VLÁKIEN

Diplomová práca je zameraná na prípravu kompozitov na báze čadičových a polypropylénových vlákien. Pripravili sa vzorky kompozitov na báze čadičových vlákien a polypropylénu s prídavkom Epolenu G 3003, Lkomontu AR 504 a retardéra horenia Rflam/12/1.

U pripravených vzoriek kompozitov sa hodnotili mechanické vlastnosti a parametre horľavosti. Vláknové kompozity sú orientované na aplikáciu do konštrukčných materiálov.

PREPARATION AND PROPERTIES OF COMPOSITES ON THE BASIS OF BASALTIC AND POLYPROPYLENE FIBRES

The thesis deals with the preparation of composites on the basis of basaltic and polypropylene fibres. Composites on the basis of basaltic and polypropylene fibres with Epolene G 3003, Lkomont AR 504 and fire retardant Rflam/12/1 were prepared and tested.

The prepared composite samples were evaluated in terms of their tensile properties and parameters of flammability. The fibres composites are directed for application as constructing materials.

Ružena Trubačová
Vedúci DP: Prof. Ing. Martin Jambrich, DrSc.
Konzultant DP: Ing. Ján Sališ, Ing. Ján Starigazda, CSc.
Recenzent: Ing. Ondrej Jačanin

VPLYV TEPLOTY PROSTREDIA NA FYZIKÁLNO - MECHANICKÉ VLASTNOSTI VLÁKIEN NA BÁZE POLYETYLÉNNAFTALÁTU

Diplomová práca je zameraná na hodnotenie štruktúry a vlastností vlákien pripravených z polyetylénnaftalátového polyméru.

Príprava polyetylénnaftalátových vlákien (PEN) sa uskutočnila diskontinuálnym spôsobom na prevádzkovom zariadení v Slovkorde a.s. Senica.

Hodnotenie štruktúry pripravených polyetylénnaftalátových (PEN) vlákien bolo orientované na parametre nadmolekulovej a morfologickej štruktúry. Hodnotenie vlastností polyetylénnaftalátových (PEN) vlákien bolo zamerané na fyzikálno mechanické parametre, pevnosť, ťažnosť, moduly pružnosti pri rozdielnych teplotách prostredia a zrážavosť pri 180 °C.

V diplomovej práci sú uvedené korelácie medzi štruktúrou a vlastnosťami polyetylénnaftalátových vlákien.

EFFECT OF AN AMBIENT TEMPERATURE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF POLYETHYLENENAPHTHALATE FIBERS

The thesis was focused on an evaluation of the structure and properties of fibres made from polyethylenenapthalate polymer.

The polyethylenenaphthalate fibres were prepared by the discontinous method at the facilities of Slovkord in Senica, the Slovak Republic.

The evaluation of the polyethylenenaphthalate fibre structures was focused on the parameters of the supra-molecular and morphological structure.

The evaluation of the properties of the polyethylenenaphthalate fibers were focused on the physical and mechanical properties (tensile strength, elongation, Young's modulus at various temperatures and contractibility at 180 °C.

The thesis includes correlations between the structure and properties of the polyethylenenaphthalate fibres.

Peter Habánik
Vedúci DP: Ing. Gajane Urban - Kočarjan, CSc.
Konzultant DP: Ing. Libuša Kováčiková
Recenzent: Ing. Eva Janišová

VPLYV TEPELNO-FIXAČNÝCH PROCESOV NA VZHĽAD A ÚŽITKOVÉ PARAMETRE ODEVNÉHO VÝROBKU

Diplomová práca sa zaoberá zložením materiálov, rozmerovými zmenami materiálov, stanovením pevnosti spoja plošných textílií a hodnotením vzhľadu skúšobných materiálov. Výsledkom bolo zistenie zloženia skúšobného odevného materiálu (vl, vl/PES, vl/PES/elastan). Boli potvrdené zmeny rozmerov odevného materiálu po žehlení a fixácii. Stanovila sa pevnosť spoja plošných textílií a parametre tepelno - fixačných procesov podľa vybraných druhov a zloženia odevných materiálov. Navrhol sa program nastavenia parametrov tepelno - fixačných procesov podľa vybraných druhov a zloženia materiálov.

EFFECT OF THERMO - FIXATION PROCESSES ON THE STYLE AND UTILITY PARAMETERS OF CLOTHING PRODUCTS

The thesis was focused on the constitution of textile materials, changes in textile dimensions, the stability of a textile printed circuit and the style of the textile materials. The results of the constitution of the textiles were presented (wool, wool/polyester, wool/polyester/elastane). Changes after ironing and fixations of the clothing textile were approved.

A programme for adjusting the parameters of the termal fixation processes was proposed, according to the selected types and compositions of the materials.

Významné životné jubileum profesora Jambricha

V novembri 2007 sa dožil v dobrom zdraví svojich 80 rokov významný vedecko-výskumný a pedagogický pracovník pán Prof. Ing. Martin Jambrich, DrSc.

Profesor Jambrich sa narodil dňa 18. novembra 1927 v Telgárte v rodine lesného robotníka. Celý jeho doterajší plodný život bol úzko spätý s chémiou. V r. 1947 absolvoval Odbornú chemickú školu vo Svite a už počas vysokoškolského štúdia na Chemicko-technologickej fakulte SVŠT v Bratislave v rokoch 1949 až 1953 začal pracovať vo funkcii asistenta a odborného asistenta. V období rokov 1956 až 1974 pracoval vo Výskumnom ústave chemických vlákien vo Svite, z toho vo funkcii jeho riaditeľa 14 rokov. V tomto období získal titul kandidáta technických vied a habilitoval na docenta.

V období 1974 až 1981 profesor Jambrich pracoval na Generálnom riaditeľstve Slovchémia vo funkcii riaditeľa pre technicko-ekonomický rozvoj. V tomto čase obhájil dizertačnú prácu a získal titul doktor technických vied.

Po celé obdobie svojej tvorivej výskumnej i riadiacej práce v rokoch 1956 až 1981 v oblasti chemických vlákien, intenzívne spolupracoval s CHTF SVŠT, kde externe prednášal predmet „Metódy hodnotenia štruktúry vlákien", bol vedúcim i konzultantom veľkého počtu diplomových prác i členom komisie pre štátne záverečné skúšky. Jeho pedagogická činnosť bola v roku 1981 ocenená menovaním za vysokoškolského profesora. V tomto roku súčasne začal opäť pracovať na CHTF SVŠT, kde zastával rôzne funkcie.

Na CHTF STU pôsobil do roku 1996. Od školského roku 1999/2000 pôsobí dodnes na FPT TnU A.D. v Púchove. Pomáhal budovať zameranie textilná a odevná technológia v rámci akreditovaného odboru Materiálová technológia. Tu vychoval 2 interné doktorandky, s titulom PhD., ďalší pod jeho vedením pracujú na experimentálnych prácach. Okrem toho viedol 30 diplomových prác, ktoré realizovali študenti Katedry textilu a odevníctva pod jeho vedením v praxi (VÚCHV, a.s. Svit, Quiltex, s r.o. Liptovský Mikuláš, Chemosvit - Fibrochem, a.s. Svit, Slovkord, a.s. Senica a v ďalších firmách).

Profesor Jambrich je významný pracovník v oblasti výskumu a vývoja technologických procesov prípravy chemických vlákien a v oblasti sledovania ich štruktúry, metód ich hodnotenia a sledovania ich vzájomných súvislostí.

Medzi najvýznamnejšie vyriešené technologické postupy patria práce v oblasti vysoko-pevných viskózových kordových vlákien realizované v tuzemsku i v zahraničí a práce v oblasti celého sortimentu vlákien v rámci Polypropylénového programu.

Významnú časť svojej práce profesor Jambrich venoval štúdiu nadmolekulovej štruktúry PA, PP a PET vlákien. Tieto práce položili teoretický základ pre postupy prípravy týchto vlákien v oblasti ich aplikovaného výskumu i vývoja. Na ich základe bolo možné definovať východiskové parametre pre vývoj technológie agregovaných postupov, vysokorýchlostného zvlákňovania a prípravy špeciálnych vlákien.

S uvedenou aktivitou je spojená rozsiahla publikačná činnosť profesora Jambricha doma i v zahraničí a náplň jeho odbornej a pedagogickej práce na vysokej škole.

Profesor Jambrich je autorom vyše 240 odborných prác, publikovaných v domácich i zahraničných periodikách. Stál pri zrode odborných časopisov Chemické vlákna a Vlákna a textil. Významne sa podieľal na organizovaní vláknarenských kongresov FIBRICHEM i Tatranských konferencií o chemických vláknach. V poslednom desaťročí ho poznáme z organizovania príprav Zjazdov chemikov v Tatrách vo funkcii člena prípravného výboru. Aj tu predniesol veľký počet zo svojich vyše 120 odborných prednášok. Je autorom viac ako 60 patentov a autorských osvedčení, autorom či spoluautorom vyše 70 výskumných prác. Spomedzi jeho 4 monografií treba vyzdvihnúť najmä Polypropylén z roku 1965 a Fyziku vlákien z roku 1987, ktorej je významným spoluautorom. Podstatnou mierou prispel ku napísaniu, zostaveniu a vydaniu významnej publikácie: História rozvoja výroby chemických vlákien na Slovensku a v Čechách, vydanej formou mimoriadneho čísla časopisu Vlákna a textil v roku 1996.

Neskôr v r.1999 spolupracoval na publikácii : História rozvoja spracovania kaučukov, gumárskej výroby a gumárskych prísad na Slovensku.

Pedagogická práca profesora Jambricha spočívala aj vo výchove 20 vedeckých a vyše 80 diplomovaných pracovníkov. Vysokú odbornosť i kvalifikovanosť menovaného ocenili prijatím za svojho člena viaceré vedecké rady pre udeľovanie vedeckých, alebo pedagogických hodností rovnako, ako redakčné rady významných domácich či zahraničných časopisov. Je členom Vedeckej rady TITK v Rudolstadte, SRN.

Fakulta priemyselných technológií TnU A.D. v Púchove a jej pracovníci prajú svojmu jubilantovi pevné zdravie a ďalšie možnosti pre využitie bohatých odborných poznatkov a cenných skúseností.