Tribomechanical and anisotropic properties of area textiles

Lubomír SODOMKA, KOD FT TU v Liberci , **lubomir.sodomka@vslib.cz**

Abstract
In the contribution it has been shown that the tribomechanical properties of the area textiles can be solved among others also using the acoustic emission (AE, stress wave emission, SWE). Textile friction is very important property used in all textile branches. Therefore to the friction are being devoted important monographies [1], [2], [3], [4]. The sliding, rolling, and Euler friction has been measured and from these data the polar diagram mapping the anisotropy using polar diagram have been plotted and from these the anisotropy quantified using the anisotropy coefficient. During the friction there are appearing also the secondary phenomena as the triboelectricity and triboluminescence are [5]. These three triboeffects acoustic emission, triboelectricity anad triboluminescence are coherent and all can be used for the friction interpretation as well as to their applications.

Key words
Textile friction, sliding, rolling, Euler friction, acoustic emission, polar diagrams, friction anisotropy

1. Introduction

The friction is very important phenomenon appearing between two material surfaces in contact. If two surfaces are at rest the static friction is being arisen. During the motion the kinetic friction is being come up. The origin of the friction is being caused through the nanoforces and is being dependent on the surface quality: the material, surface quality and on the surface roughness. Also in the textile fields is the friction very important : it is doing the clothing and the human skin friction, friction between two different textilies, friction at textiles production. The friction is being also accompanied with the electrostatical as well as optical phenomena.
Technical surfaces are very heavy defined and what is easy accessible for the measurement is the surface profile. In the last time there is being appeared the new equipment called KES (Kawabata Evaluation System) enabling the synchronous measurements of the surface roughness and friction coefficient. One measuring unit is being able to measure contemporary the surface roughness and friction coefficient [6]. The surface characteristics measurements of polypropylene woven fabrics (PP200+30) are being shown on fig.1 and web fabrics Pegatex on fig.2.
From these measurements in dependence on the angle convolution the mechanical moduli and friction anisotropy of area textile can be determined. Using the KES measurements it is impossible to determine the Poisson number of textiles, which is relatively easy measurable applicating the mask pattern method [7],[8]. as well as to evaluace directly in vivo the friction between the human skin and textile fabrics. In these cases the another means have to be used , from which the new and effective is the stress wave emission (SEW) or less exactly acoustic emission (AE).

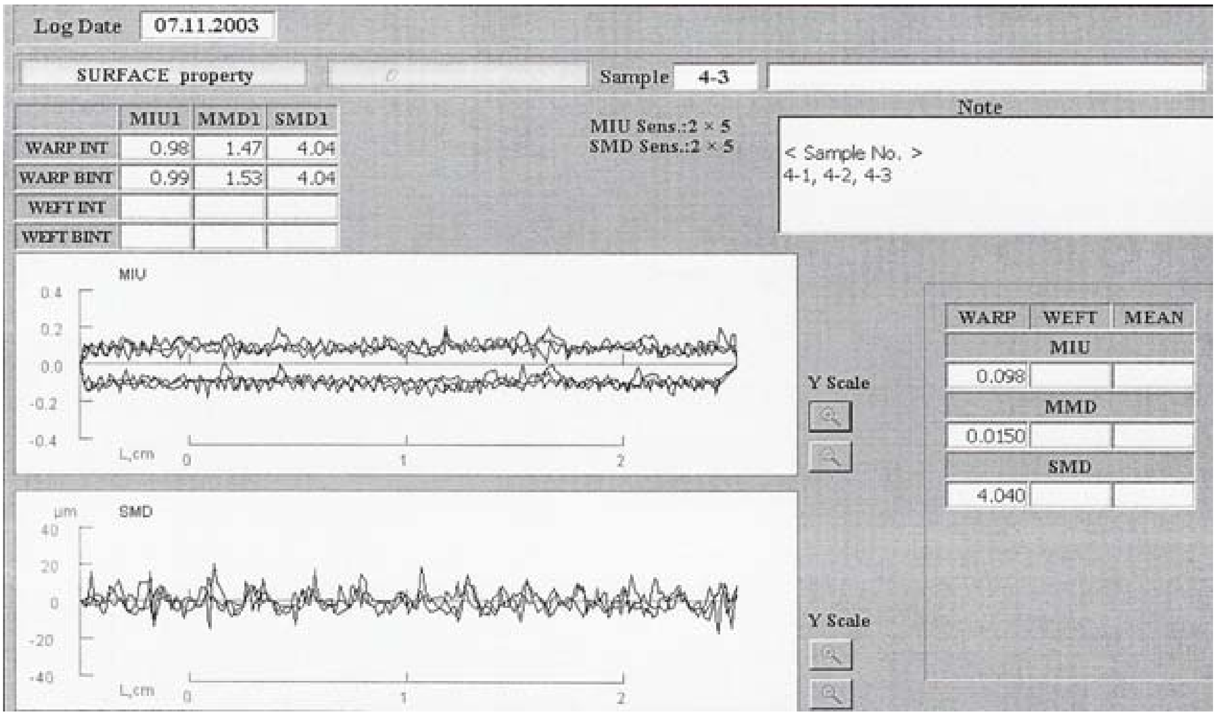


Fig.1 Friction coefficient of and surface profile of PP200+300 using KES

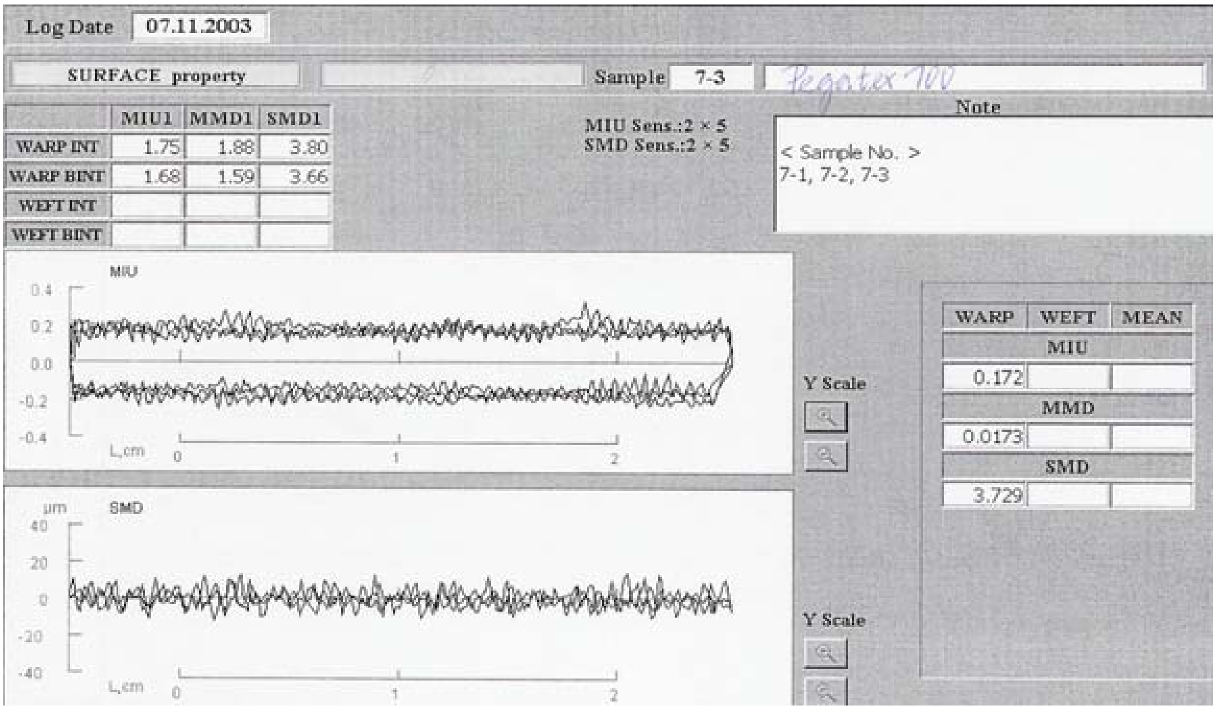
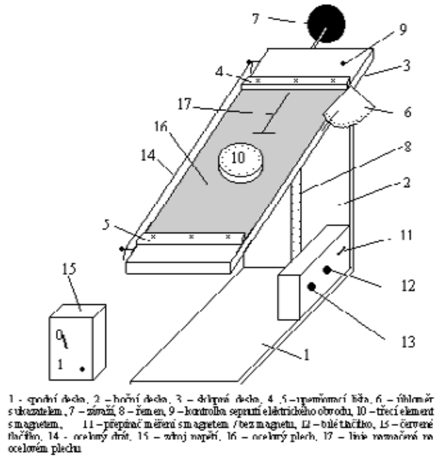


Fig.2 Friction coefficient of and surface profile of Pefatex 100 using KES

2. Textile fiction coefficient measurements

2.1 Influence of principal weave on the friction coefficient

The fundamental weaves plain, twill and satin are being appeared anisotropic, it has been expected also the anisotropy of friction coefficient. The measurements have been shown that the expectation has not been so unique. In the [9] for example has been shown the friction coefficient of cotton wovens fabrics have been quite isotropic.
The friction measurements have been made for all three types friction : the sliding, the rolling as well as the Euler (wrap) friction with synchronous measurements of ESW (AE). The sliding friction coefficient has been measured on the tribometer using the inclined plain. The principle together with the realization is being presented on fig.3.

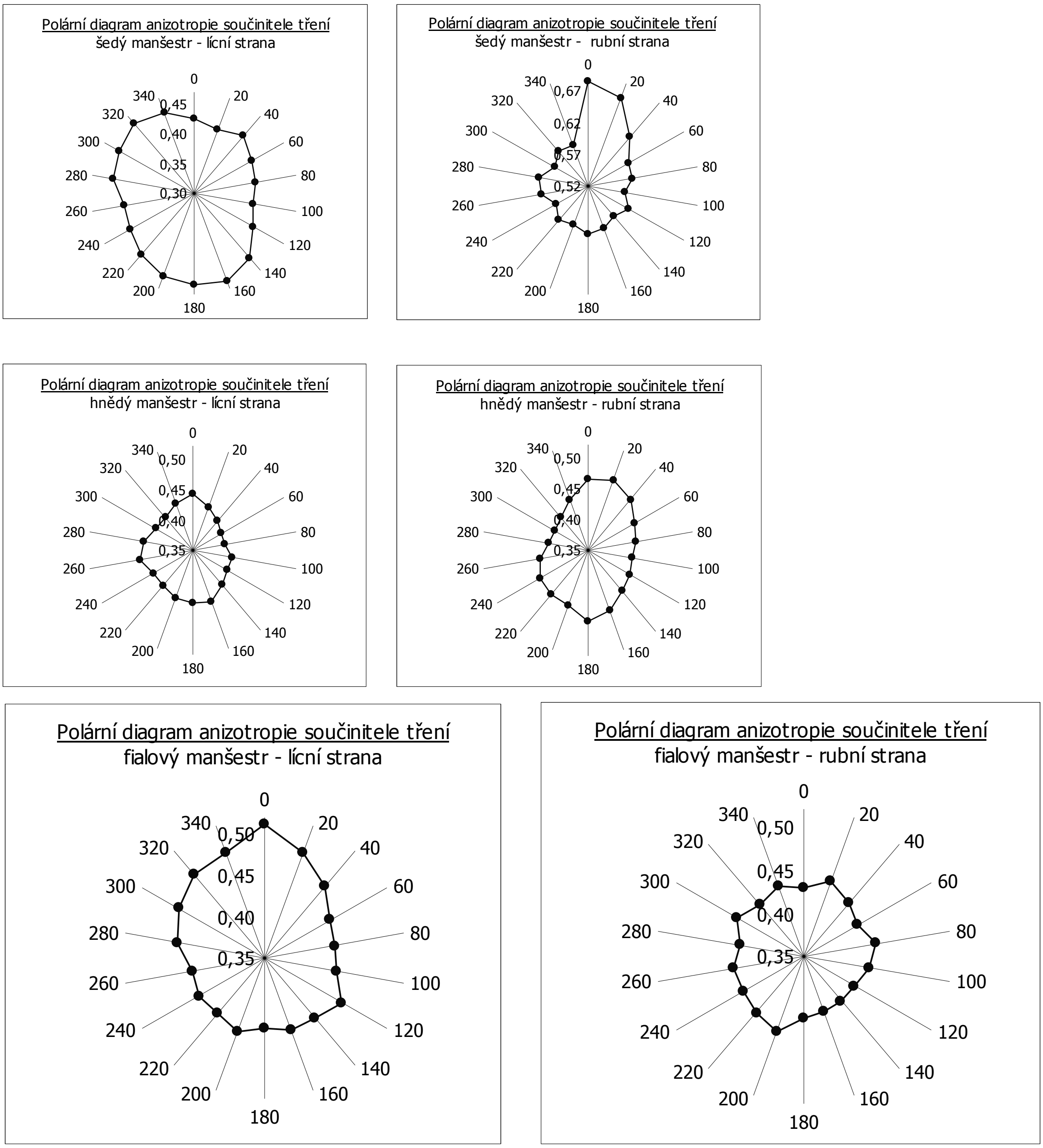


Obr.3 The sliding tribometer

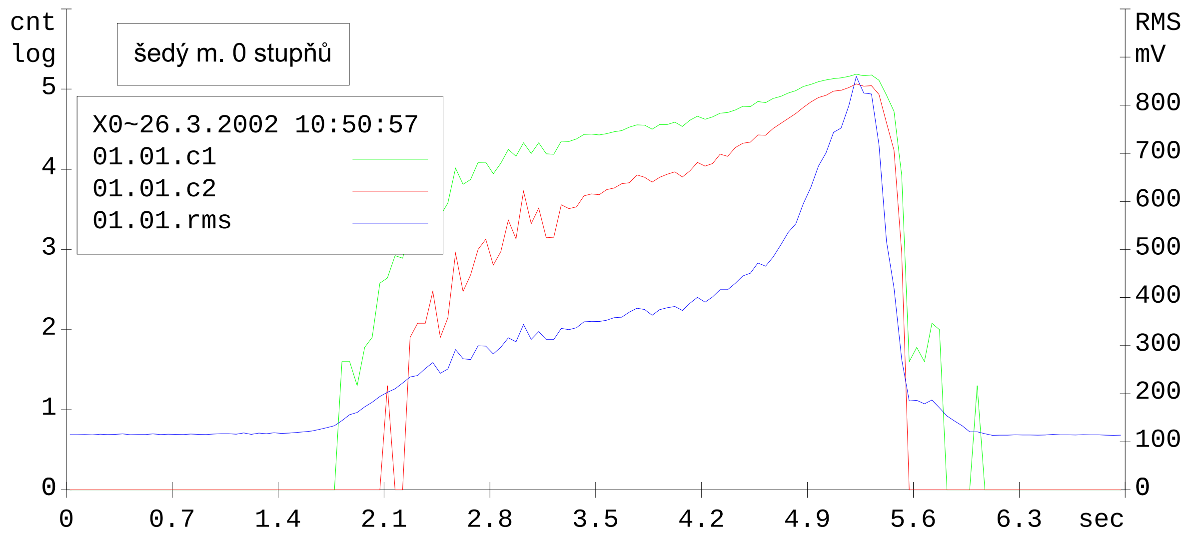
The textile probe has been fastened on the 100mm diameter circular plate affixed with scale in degrees with the possibility to adjust the friction in the sliding direction. The measurements in all possible direction is being enabled to construct the polar diagrams describing the probe anisotropy.

2.2 Friction coefficients of the needlecord woven fabrics

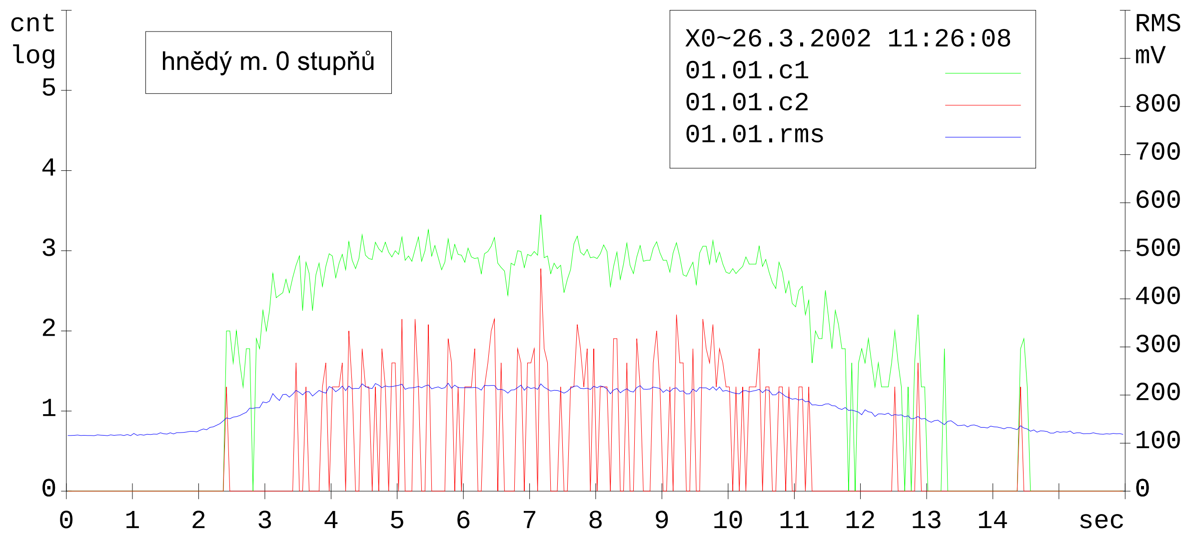
The needlecord woven fabrics have on the face the parallel stripes. For our measurements the three typed of needlecord woven have been chosen: finely striped gray needlecord woven, middle striped brown and rough striped violet needlecord detailed described in [10]
The measurements of the needlecord fiction coefficient anisotropy have been done on the tribometer on the fig.3 in dependence on the sliding friction direction and synchronously also the the SWE (AE) heve been detected. The results are being presented on the fig.4 and 5.



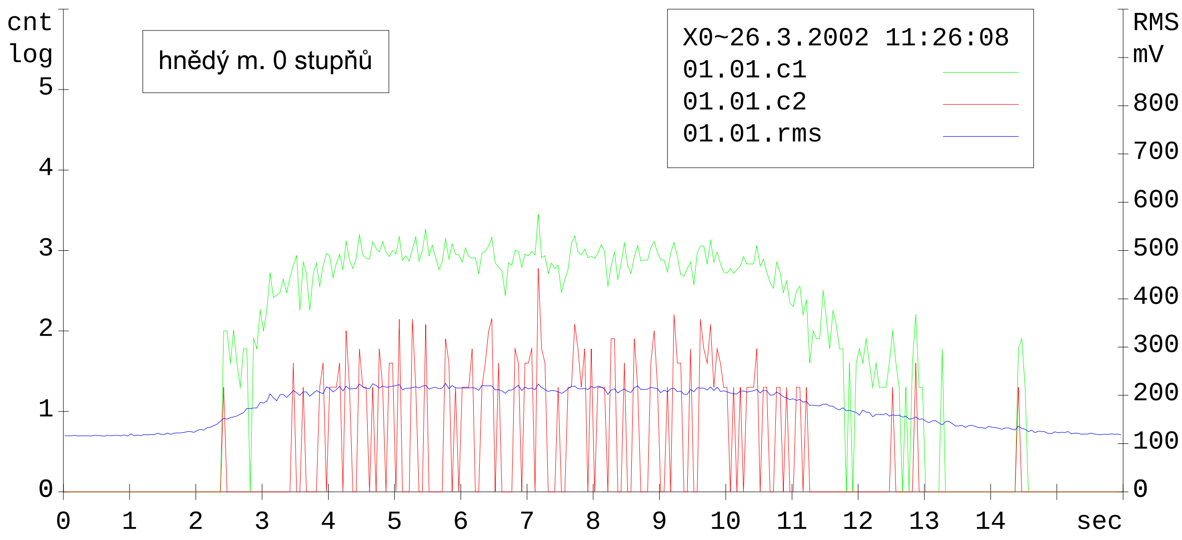
Obr.5 Anizotropy of needlecord woven fabrics presented as polar diagrams



gray needlecordin the warporientation



brown needlecord in the warp direction



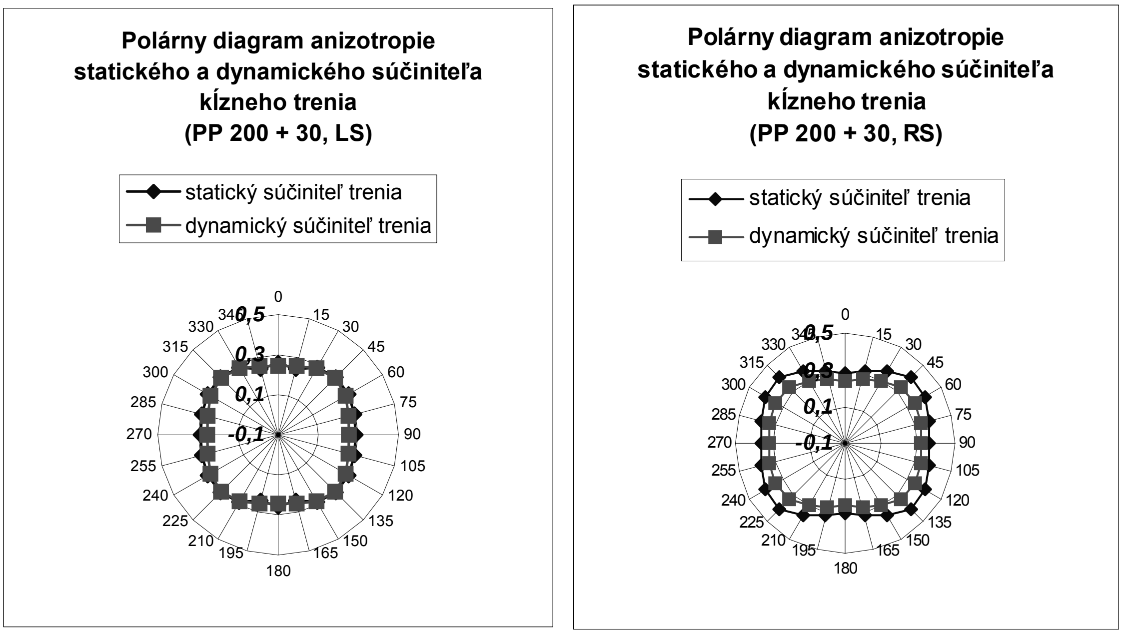
violetrte needlacord in the warp direction

Obr.6 SWM (AE) spektra of needlecord woven fabrics

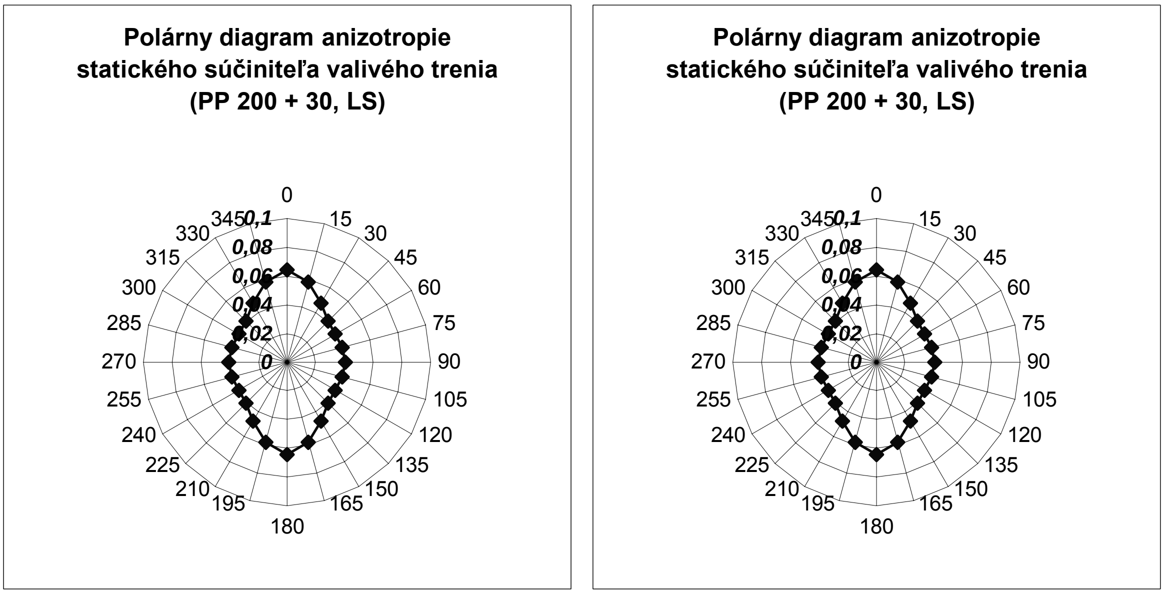
The SWE measurements has been shown that this methods is very sensitive to the friction of the hair woven fabrics against the stainless steel and as well as to the friction anisotropy. In the warp and 45^0 direction the SWE events have a pulsed retarded form in the another ones the continuous form. The SWE spectra is for the each textile and friction direction unique and characteristic.

2.3 Friction coefficients of the polypropylene woven fabrics

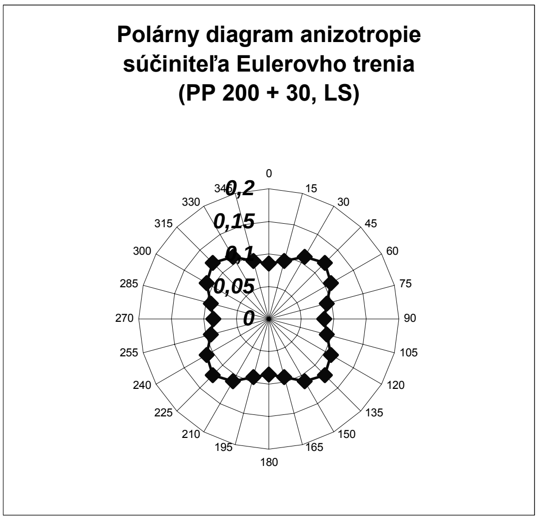
The friction coefficients of the needlecord woven fabrice has been measured partly for the sliding partly for the rolling and partly for the wrap (Euler) friction. For the measurements the following polypropylene woven fabrics pointed out as PP200+30. The first number is explaining the area mass (g/m^2) and the second one is being indicated the area mass of the adhesive laminated surface layer. The details are being introduced in [11]. The measured results are being presented on the fig.7 , 8 and 9. On the fig.7 is being seen the measurements of the sliding friction, on the fig.8 the rolling and on the fig.9 the Euler (wrap) friction measurements are being demonstrated. In the upper figure parts the polar diagrams and in the lower parts the SWE spectra of the friction are being introduced.

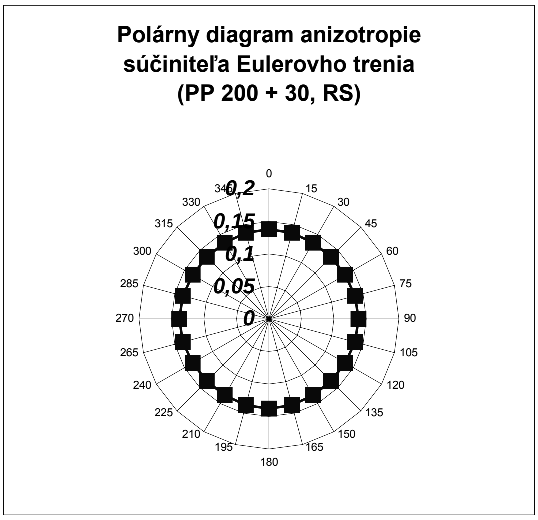


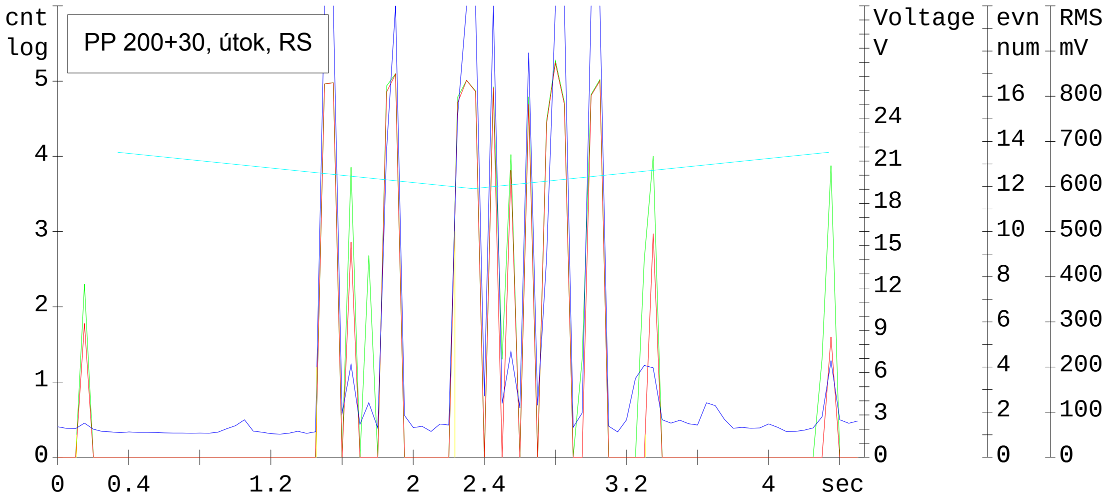
Obr.7 Results of friction measurements of the sliding friction for PP200+300

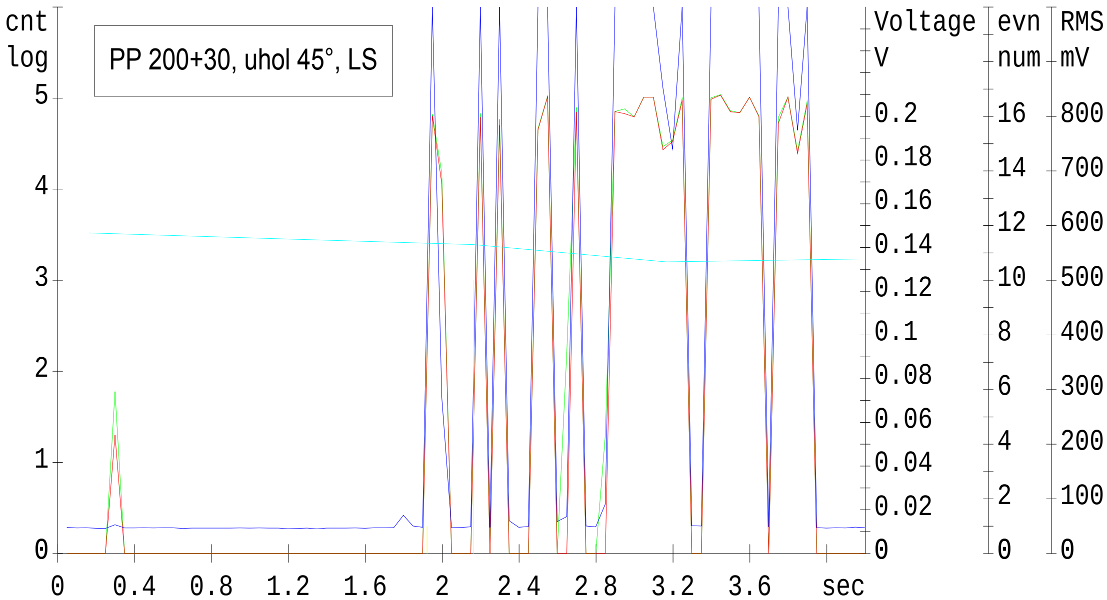


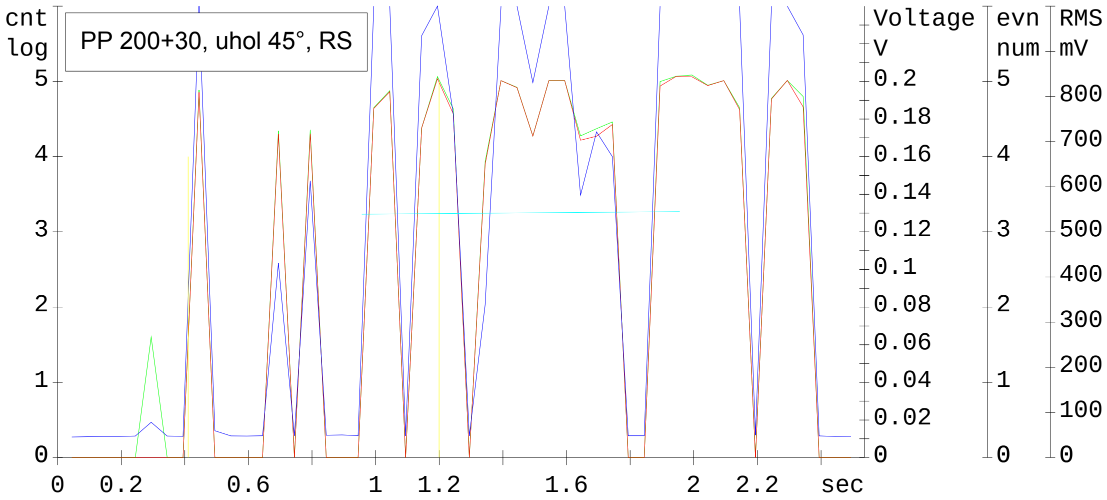
Obr.8 Results of friction measurements of the rolling friction for PP200+300


Polárny diagram anizotropie
súčiniteľa Eulerovho trenia
(PP 200 + 30, LS)


Polárny diagram anizotropie
súčiniteľa Eulerovho trenia
(PP 200 + 30, RS)


PP 200+30, útok, RS
cnt
log
Voltage
V
evn
num
RMS
mV
sec


PP 200+30, uhol 45°, LS
cnt
log
Voltage
V
evn
num
RMS
mV
sec



Obr.9 Results of friction measurements of the Euler (wrap) friction for PP200+300

3. Results discussions and estimation

Already in the forgoing papers for instance in [12], [13], [14] has been shown that SWE (AE) is possible to use also to the textile evaluation. The AE spectra are being indentified the individuality of anyone textile fabrics and anyone friction direction in textile fabrics. The main application is in the evaluation of the anisotropy, the for breaking textile state for example of textile rows and furthers. This is being reported in another place on posters of this conference [15].

It has been confirmed that the SWE is possible to use in the diagnostic of the mechanisms occurring in the textiles during their mechanical deformation.

It has been shown that the SWE method is enough sensitive to detect the friction of the hair needlecord textiles.

In the contribution it has been shown from the measurements of the polypropylene wovens and distinguish the right and wrong sides of the textiles. The SWE is being explaing in most cases through the friction mechanism of the fibers in textile bonds and the mechanism of the stick/slip and its motion and also through the inner friction in fibers.

Before the textile textiles break the AE spectra are being indicated and observed the single fiber breaking.

The SWE method has been shown as the supplement for the textile mechanical properties research which are being provided the more delicate phenomena taking place at the textile deformations.

This contribution has been supported with GACR Prague CR sub number 106- 01- 383.

4. References

[1] Howell, H., G., et al.: Friction in Textiles. Butterworth London 1959

[2] Schick,M.J.: Surface characteristics of fibers and textiles, part I.chap1 . M.Dekker, N.Y.1975

[3] Persson, B.N.J.: Sliding friction. Springer Berlin 1998,2000

[4] More,D.,F.: Principles and Applications of tribology. Pergamo, London 1975

[5] Sodomka,L.: Mechanoluminiscence a její použití. Academia Praha 1986

[6] Sodomka,L.: Triboelektřina a textilní zarážky. JMO 31,1981,str.9
Sodomka,L.: Triboelektrická textilní zarážka. Textil 36,1981,82
Sodomka,L.: Materiál pro triboelektrické zarážky. AO 213 929 ČSFR.

[7] Kawabata,S., Postle,R., Niwa Masako.: Objective specification of fabric quality mechanical properties and performance. The Textile Machinery Society of Japan Kyoto 1982
[8] Sodomka,L., Dudíková,M., Gluštíková., G : Strutex
[9] Sodomka,L., Dudíková,M., Gluštíková., G : http://gacr.kod.vslib.cz
[10] Mlsnová,M.: Součinitel tření manšestrových tkanin a anizotropie jejich mechanických vlastností.DP KOD FT TU V Liberci CR, 2002
[11] Bubeníková ,V.: Vybrané mechanotribologické vlastnosti polypropylénových tkanín a rúnin.DP KOD FT TU v Liberci,CR ,Liberec 2
[12] Sodomka, L.: Akustická emise textilií a jejich anizotropie. Vlákna a Textil 9,2002, č.3,str.99
[13] Sodomka,L., Fiala,J.: Fyzika a chemie kondenzovaných látek s aplikacemi. Adhesiv Liberec 2003 , kap.5.6 str. 206
[14] Sodomka,L., et al.: Struktura a mechanické vlastnosti nosných, tažných a závěsných lan. Sborní příspěvků Defektoskopie 2003 Ostrava,str.227.
[15] Sodomka,L.: Acoustic emission in textile fields. Poster of this conference.
[16] Persson,B.N.J.: Sliding fiction . Springer Berlin, second edition 2000