Application Note
V-244

"Psycho-tribological" measurements on cloth materials with a rheometer and a novel measuring geometry

This report was presented at the 81th SOR Meeting 2009 in Madision, USA, by
Stefanie Rudolf, Albstadt-Sigmaringen University, Albstadt, Germany
Boris Bauer, Hohenstein Institute, Schloss Hohenstein, Boennigheim, Germany
Jint Nijman, Thermo Fisher Scientific, Process Instruments, Karlsruhe, Germany

Introduction

Manufacturers of technical textiles or competing leather or artificial leather (PVC) materials designed for the use in car interiors have to offer products with good haptic properties but objectively quantifying and measuring haptic properties is very difficult. In this paper new techniques for measuring the haptic properties of textiles, leather and artificial leather materials used for car seats are described. For these measurements a standard rheometer (Fig. 1) equipped with an especially developed novel measuring geometry (Fig. 2a, 2b, 2c, 2d) was used. The material samples were submitted to normal force hysteris and rotational friction measurements (tribological measurements). The measured data sets were correlated with the subjective sensations of test persons obtained in seat trials. The aim of the actual investigations was the development of a feasible measuring and evaluating system that can be used by the textile industry to improve the haptic properties of their products.

Measurement set-up

In total 8 cover materials for car seats were investigated, namely 4 textile cover materials (fabrics and composite materials), 1 artificial leather (PVC) cover material and 3 leather cover materials.

For the measurements of the compression deformation behaviour (for an example see Fig. 3) a parallel-plate type measuring geometry was used (diameter 60 mm).

The samples were successively loaded/unloaded by a series of normal forces F_n of 1 N, 5 N, 10 N, 5 N and 1 N. The measuring time of every normal force level amounted 60 seconds.

From the data sets the following parameters were derived:

- h_{1B} the thickness of the samples (measured under load F_n of 1 N),
- ρ_t the density (defined as the quotient of the area-weight and h_{1B} the thickness of the samples),

Fig. 1: Thermo Scientific HAAKE MARS III rheometer

- Δh_{1_10} the total deformation (defined as the difference between the thickness of the samples measured and a load F_n of 1 N and 10 N) and
- Δh_{1BE} the plastic deformation (defined as the difference of thickness of the samples under a load F_n of 1 N during the loading and the unloading procedure).

For the friction measurements (for an example see Fig. 4) a flat ring-rotor type measuring geometry was used with an inner diameter of 27 mm and an outer diameter of 35 mm (Fig. 2c, 2d). This geometry was especially developed for this application in order to obtain a more uniform friction speed between the sample and the rotor. The measurements were performed with a constant circumferential speed of 1 mm s^{-1} (CR-mode) at the outer rim of the ring. The normal force was varied with five levels of 1, 5, 10, 15 and 20 N. The measuring time for each force level amounted 60 seconds. From these data sets the torque M, friction force F_f, normal force F_n and angular speed Ω were recorded.

Fig. 2a: Sample clamp device

Fig. 2b: Sample clamp device with sample

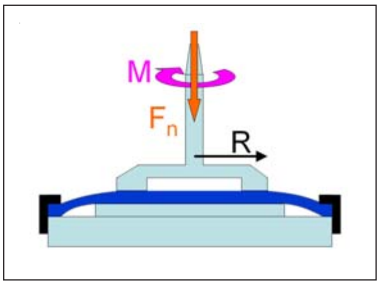

Fig. 2c: Plate-Ring geometry

Fig. 2d: Measurement set-up

Results

Regarding the deformation behaviour (Fig. 5a,b), in particular the nonwoven based composite materials show a relatively high thickness h_{1B}, a high total deformation Δh_{1_10} and also a high plastic deformation Δh_{1BE}.

From the friction measurements a linear relation between the normal force F_n and the friction force F_{f1} was obtained (Fig. 5c).

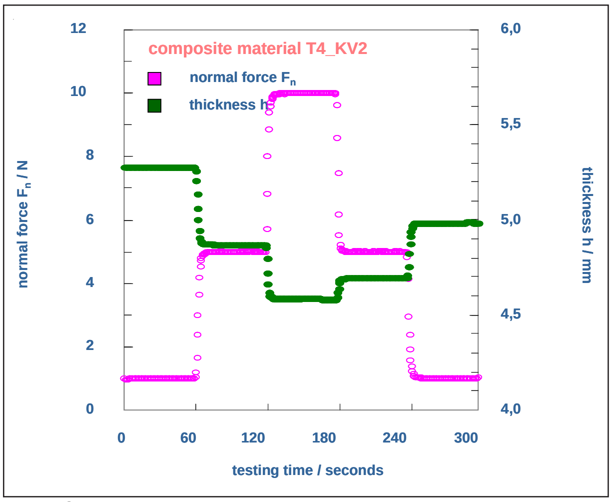

Fig. 3: Compression measurements

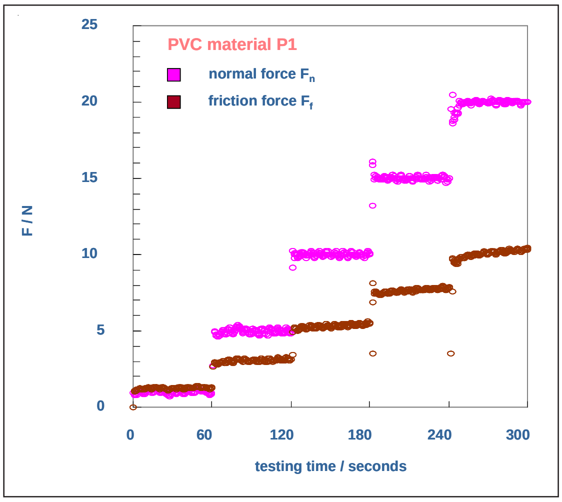

Fig. 4: Friction measurements

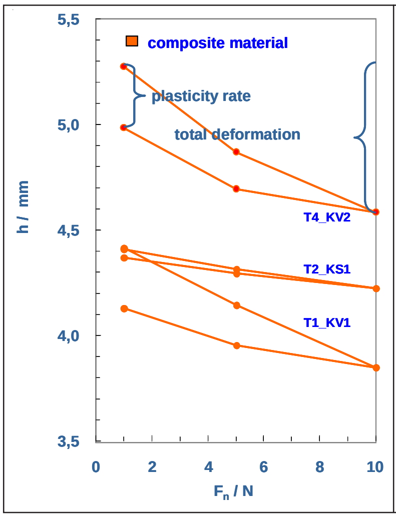

Fig. 5a: Compression deformation behaviour of textile composite materials

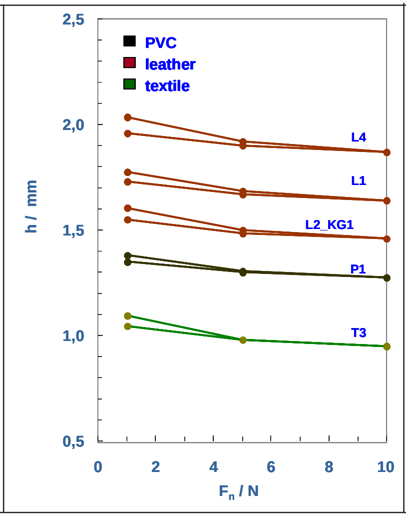

Fig. 5b: Compression deformation behaviour of textiles, leather and artificial leather

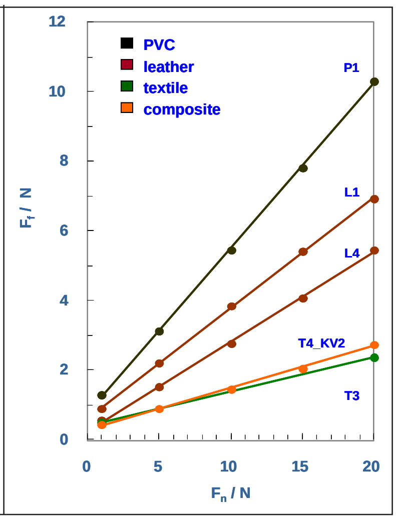

Fig. 5c: Friction behaviour of textiles, leather an artificial leather

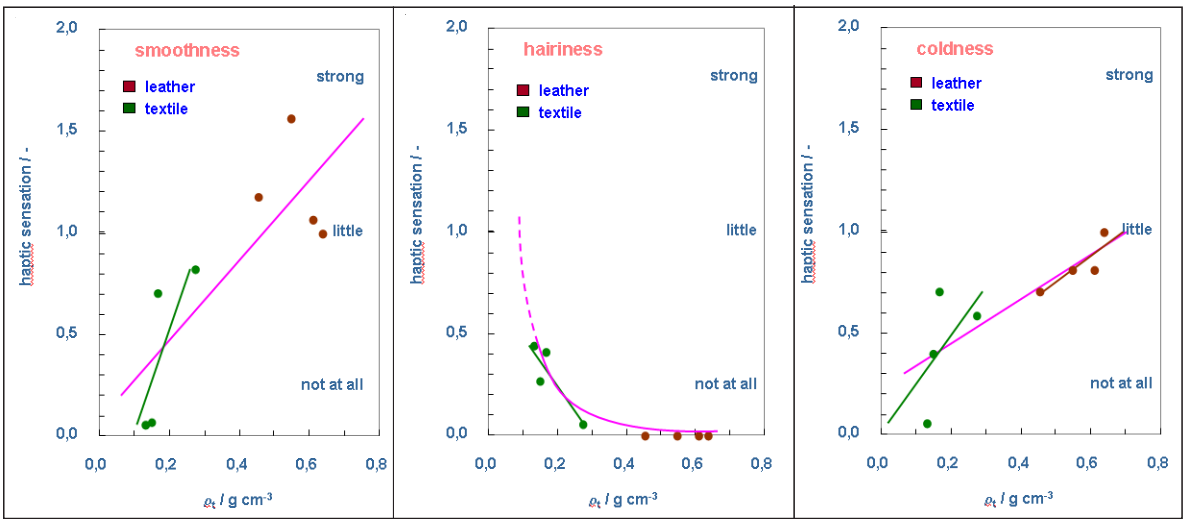

Fig. 6: Correlations between density ρ_t and the subjective haptic properties of the cover materials

The friction values found for the artificial leather cover material (PVC) are clearly higher than those for the leathers which again are clearly higher then those found for the textile cover materials; the different materials are clearly distinguishable.

The haptic properties of the cover materials investigated were determined in seat trials with test persons. In total 11 haptic sensations (coldness, hairiness, smoothness, stickiness, softness, fleeciness, clamminess, rawness, roughness, stiffness, hardness) were evaluated by means of a 2-level scale (0 = not at all, 1 = little, 2 = strong). Besides that the general haptic comfort impression was evaluated by means of a 6-level scale (from 1 = very good up to 6 = insufficient).

The density ρ_t of the cover materials investigated (Fig. 6) correlates with the smoothness sensations (R^2 = 0.65), the hairiness sensations (R^2 = 0.76) as well as the coldness sensations (R^2 = 0.66). The friction force F_{f1} (Fig. 7) correlates with the rawness sensations (R^2 = 0.86) and the general haptic comfort impression (R^2 = 0.66).

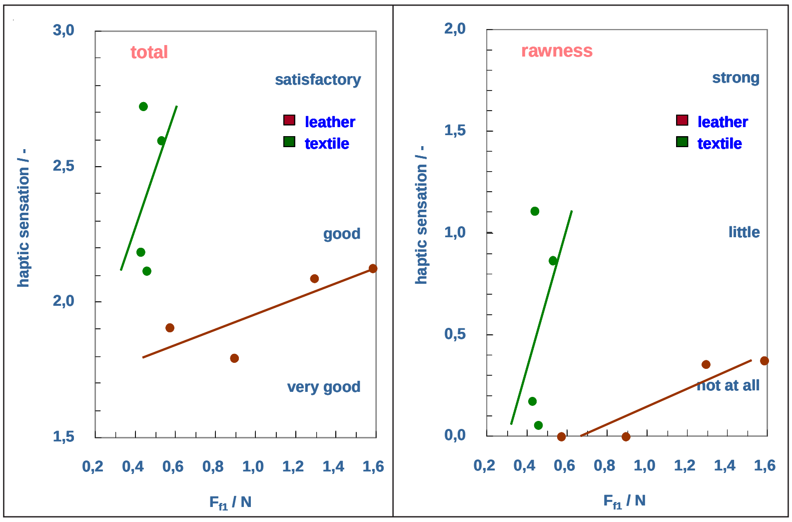

Fig. 7: Correlations between friction force F_{f1} and subjective haptic properties of the cover materials

Conclusions

The correlations found show that haptic sensations are not quite subjective but caused by mainly physical interactions between human's skin and cover material. For this reason they can be measured in some degree by means of physical measuring methods like rheometer. The investigations will be continued.

Process Instruments

International/Germany
Dieselstr. 4,
76227 Karlsruhe
Tel. +49(0)721 40 94-444
info.mc.de@thermofisher.com

Benelux
Tel. +31 (0) 76 5 87 98 88
info.mc.nl@thermofisher.com

China
Tel. +86 (21) 68 65 45 88
info.mc.china@thermofisher.com

France
Tel. +33 (0) 1 60 92 48 00
info.mc.fr@thermofisher.com

India
Tel. +91 (20) 66 26 7000
info.mc.in@thermofisher.com

Japan
Tel. +81 45 453 9167
info.mc.jp@thermofisher.com

United Kingdom
Tel. +44 (0) 1606 54 81 00
info.mc.uk@thermofisher.com

USA
Tel. 603 436 9444
info.mc.us@thermofisher.com

www.thermoscientific.com/mc

V-244_12.09

© 2009 Thermo Fisher Scientific Inc.· All rights reserved · This document is for informational purposes only and is subject to change without notice.