Emtec TSA – Textile Softness Analyzer: A new and objective way to measure smoothness, softness and stiffness of textiles.
Importance of a soft touch for consumers

What consumers want: **Softness**

- Design / Style
- Color/Pattern
- Trend
- Brand
- Durability
- Quality
- Price
- Soft Fabric
- Comfortable fit
- Skin friendly

Source: Lenzing customer survey, n23
Agenda

1. The Human Feeling / Traditional Softness Measurement
2. Technical Principle of the TSA
3. Application Examples
4. Conclusion
1. The Human Feeling / Traditional Softness Measurement

Four different types of cells / bodies are located in the finger tips of every human:

- Lamellar corpuscles / Pacinian corpuscles (A)
- Tactile corpuscles / Meissner corpuscles (B)
- Tactile cells / Merkel cells (C)
- Ruffini bodies (D)
1. The Human Feeling / Traditional Softness Measurement

(A) Lamellar corpuscles / Pacinian corpuscles

Responsible for the measurement of the real softness of a material

(B) Tactile corpuscles / Meissner corpuscles

Responsible for the measurement of the roughness of a material

(C) Tactile cells / Merkel cells

Both are responsible for the measurement of the stiffness of a material

(D) Ruffini bodies
1. The Human Feeling / Traditional Softness Measurement

**Procedure of testing textiles:**

**Test:**

- Hand moves over the sample surface.
- Sample is “crumpled” by the hand.

Generation of different vibrations, shear forces and resistance forces against deformation depends on:

- real softness (comes from the fibers)
- felt smoothness / roughness
- stiffness
1. The Human Feeling / Traditional Softness Measurement

Different signals — via nerves — Brain — Impression of "softness" or better: hand feel or touch
1. The Human Feeling / Traditional Softness Measurement

Hand Feeling/Touch:

- a combination of three basic parameters
- these parameters are detected from the four sensors/cells in the finger tips

These three parameters are:

- **Softness** (mainly determined by the fiber stiffness and behavior; affected also by chemicals)
- **Roughness/smoothness** (mainly determined by embossing)
- **Stiffness** (mainly determined by the fiber behavior, production technology, chemicals)

**But:** Different sensitivity of the sensors in the finger tips; different preferences of the people.

Each person weights the three parameters differently. Therefore, each person achieves different results.
1. The Human Feeling / Traditional Softness Measurement

**Problems of Handfeel test**

- Sensitivity of hands varies
- Separating the basic parameters is not satisfactorily possible
- Results dependent on: Testing procedure, personal preferences, market specific preferences, culture, mood, etc.
1. The Human Feeling / Traditional Softness Measurement

The only solution for this problem is the use of an **objective technical device**

**TSA – Textile Softness Analyzer**

- Measuring Head
- Rotor with blades
- Measuring Cell, incl. fixing ring, load cell, microphone
- Cancellation of surrounding noise
2. Technical Principal of the TSA

The TSA can measure the three basic parameters, that determine our human hand feeling:

- the real softness
- the smoothness
- The displacement / stiffness

The availability of these three basic parameters is a big step forward, it hasn’t been possible to measure them before objectively and reliably.

From these three parameters and some others (e.g. humidity, temperature) a human hand feel or touch value can be calculated, adapted to the respective product and/or market.
2. Technical Principal of the TSA

TSA measurement = Two Steps:

1. Sound Analysis (real softness, smoothness)

2. Deformation Measurement (displacement)
2. Technical Principal of the TSA

First Step – Sound Analysis

Measuring the smoothness

Measuring the real softness
2. Technical Principal of the TSA

Results First Step

- TS750 peak – smoothness / roughness
- TS7 peak – real softness / hardness

RMS

- sample B - 100mN - side A (4)
- sample C - 100mN - side A (6)
- sample E - 100mN - side A (5)

High-Tex from Germany, Atlanta 2018
2. Technical Principal of the TSA

Second Step – Deformation Measurement

Determined by the measurement of the sample deformation under a defined force

Result Second Step

Deformation in mm/N

1. F = 100mN

2. F = constant = 600mN

High-Tex from Germany, Atlanta 2018
2. Technical Principal of the TSA

<table>
<thead>
<tr>
<th>Filename</th>
<th>Label</th>
<th>HF</th>
<th>TS7</th>
<th>TS750</th>
<th>D [μm]</th>
<th>Grayscale [g/m²]</th>
<th>Piles</th>
<th>Algorithm</th>
<th>Scale</th>
</tr>
</thead>
</table>

**Stiffness Measurement – D**

**Sound spectrum – TS750, TS7**

**HF = f(TS7, TS750, D, caliper, grammage, number of plies)**

HF: combination parameter for the hand feeling

- **TS7**: real softness (comes from the fibers, lower peak = higher softness)
- **TS750**: felt softness / roughness (lower peak = higher smoothness)
- **D**: stiffness (lower number = higher stiffness)
2. Technical Principal of the TSA

Three basic parameters of haptic

- Real softness (TS7)
- Smoothness (TS750)
- Stiffness (D)

Calculated handfeel numbers HF
(based on standard models or adapted to the respective customers hand feel panel)

Additionally and with the same measurement, the following parameters are measured:

- Elasticity (E)
- Plasticity (P)
- Hysteresis (H)

The test of one sample takes about 40 seconds. Per material it is recommended to do between 5 – 8 repetition measurements.
2. Technical Principal of the TSA

Hand Feel (HF) calculation

The hand feel is calculated from the three basic parameters:

- real softness (TS7), smoothness (TS750), stiffness (D) and
- thickness of the material, number of plies, temperature and rel. humidity ...

The hand feel (HF) number is a calculated number.

Since hand feel is a subjective feeling, which differs from region to region and also from application to application, the algorithms need to be region and application specific.

The calculated number depends on how the three parameters are combined (similar to our human feeling).
2. Technical Principal of the TSA

Hand Feel (HF) calculation

<table>
<thead>
<tr>
<th>Label</th>
<th>Sample 1</th>
<th>Sample 1</th>
<th>Sample 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>HF</td>
<td>78,9</td>
<td>78,3</td>
<td>83,7</td>
</tr>
<tr>
<td>TS7</td>
<td>13,724</td>
<td>13,724</td>
<td>13,724</td>
</tr>
<tr>
<td>TS750</td>
<td>6,086</td>
<td>6,086</td>
<td>6,086</td>
</tr>
<tr>
<td>E [mm/N]</td>
<td>2,26</td>
<td>2,26</td>
<td>2,26</td>
</tr>
<tr>
<td>D [mm/N]</td>
<td>3,14</td>
<td>3,14</td>
<td>3,14</td>
</tr>
<tr>
<td>H [J]</td>
<td>141,8</td>
<td>141,8</td>
<td>141,8</td>
</tr>
<tr>
<td>P [um]</td>
<td>-567,6</td>
<td>-567,6</td>
<td>-567,6</td>
</tr>
<tr>
<td>Caliper [µm]</td>
<td>50,0</td>
<td>50,0</td>
<td>50,0</td>
</tr>
<tr>
<td>Grammage [g/m²]</td>
<td>11,0</td>
<td>11,0</td>
<td>11,0</td>
</tr>
<tr>
<td>Plies</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Algorithm</td>
<td>base tissue I</td>
<td>facial III</td>
<td>TP II</td>
</tr>
<tr>
<td>Temperature [°C]</td>
<td>19,8</td>
<td>19,8</td>
<td>19,8</td>
</tr>
<tr>
<td>Humidity [%]</td>
<td>62,4</td>
<td>62,4</td>
<td>62,4</td>
</tr>
</tbody>
</table>

Three times the same sample, all parameters stay the same, only the HF value changes with the used algorithm.
3. Application Examples

Optimization of the hand feel / touch by testing different additives in the textile converting.
3. Application Examples

Optimization of the hand feel / touch by testing different additives in the textile converting

Description of the trial: Target – test of the efficiency of three different additives!

Three different additives have been tested at 3 different materials at three different concentrations; one at a time, to make sure that possible changes can be allocated.

All three materials (different fiber mix) have been treated with the same:

(a) Softness agent
(b) Smoothness agent
(c) Stiffness agent

The samples have been tested with the emtec TSA, because only this device can measure these three parameters separate from each other.

In the following a selection of the results is presented.
### 3. Application Examples

Optimization of the hand feel / touch by testing different additives in the textile converting.

#### Quality parameters of the untreated material

<table>
<thead>
<tr>
<th>Sample</th>
<th>Softness TS7</th>
<th>Smoothness TS750</th>
<th>Displacement D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>5.490</td>
<td>51.202</td>
<td>2.68</td>
</tr>
<tr>
<td>2.0</td>
<td>7.706</td>
<td>30.858</td>
<td>3.11</td>
</tr>
<tr>
<td>3.0</td>
<td>10.140</td>
<td>30.585</td>
<td>3.40</td>
</tr>
</tbody>
</table>

- The lower the number, the softer is the material.
- The lower the number, the smoother is the material.
- The higher the number, the more flexible is the material.

High-Tex from Germany, Atlanta 2018
### 3. Application Examples

**Material 1**

1.0 = untreated material, 1.1 = treatment with different amounts of softness agent, 1.2 = treatment with different amounts of smoothness agent, 1.3 = treatment with different amounts of stiffness agent

<table>
<thead>
<tr>
<th>Sample</th>
<th>Real softness TS7</th>
<th>Roughness TS750</th>
<th>Stiffness D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 1.0</td>
<td>5.490</td>
<td>51.202</td>
<td>2.68</td>
</tr>
<tr>
<td>Sample 1.1 (10g/l)</td>
<td>5.226</td>
<td>48.925</td>
<td>2.62</td>
</tr>
<tr>
<td>Sample 1.1 (20g/l)</td>
<td>5.222</td>
<td>49.837</td>
<td>2.64</td>
</tr>
<tr>
<td>Sample 1.1 (30g/l)</td>
<td>5.611</td>
<td>49.824</td>
<td>2.58</td>
</tr>
<tr>
<td>Sample 1.2 (10g/l)</td>
<td>5.990</td>
<td>47.860</td>
<td>2.75</td>
</tr>
<tr>
<td>Sample 1.2 (20g/l)</td>
<td>5.639</td>
<td>51.154</td>
<td>2.73</td>
</tr>
<tr>
<td>Sample 1.2 (30g/l)</td>
<td>5.696</td>
<td>46.983</td>
<td>2.79</td>
</tr>
<tr>
<td>Sample 1.3 (10g/l)</td>
<td>7.274</td>
<td>73.759</td>
<td>1.98</td>
</tr>
<tr>
<td>Sample 1.3 (20g/l)</td>
<td>7.608</td>
<td>78.340</td>
<td>1.94</td>
</tr>
<tr>
<td>Sample 1.3 (30g/l)</td>
<td>8.482</td>
<td>102.649</td>
<td>1.50</td>
</tr>
</tbody>
</table>

- **Sample 1.1 – softness agent**
  - **TS7**: Almost no influence by the softness agent (even with an increasing amount)
  - **TS750**: The softness agent has a positive influence on the smoothness
  - **D**: No influence

- **Sample 1.2 – smoothness agent**
  - **TS7**: A very small, but negative influence to the softness
  - **TS750**: Smoothness increases with an increasing amount of smoothness agent
  - **D**: Almost no influence

- **Sample 1.3 – stiffness agent**
  - **TS7**: A very negative impact to the real softness
  - **TS750**: A very negative impact to the smoothness
  - **D**: The material becomes stiffer with an increasing amount of stiffness agent.
### 3. Application Examples

#### Optimization of the hand feel / touch by testing different additives in the textile converting

<table>
<thead>
<tr>
<th>Sample</th>
<th>Real softness TS7</th>
<th>Roughness TS750</th>
<th>Stiffness D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 2.0</td>
<td>7.706</td>
<td>30.858</td>
<td>3.11</td>
</tr>
<tr>
<td>Sample 2.1 (10g/l)</td>
<td>6.897</td>
<td>23.122</td>
<td>3.36</td>
</tr>
<tr>
<td>Sample 2.1 (20g/l)</td>
<td>6.958</td>
<td>26.842</td>
<td>3.34</td>
</tr>
<tr>
<td>Sample 2.1 (30g/l)</td>
<td>6.796</td>
<td>24.471</td>
<td>3.51</td>
</tr>
<tr>
<td>Sample 2.2 (10g/l)</td>
<td>7.517</td>
<td>25.240</td>
<td>3.45</td>
</tr>
<tr>
<td>Sample 2.2 (20g/l)</td>
<td>6.299</td>
<td>24.972</td>
<td>3.88</td>
</tr>
<tr>
<td>Sample 2.2 (30g/l)</td>
<td>6.389</td>
<td>23.331</td>
<td>3.97</td>
</tr>
<tr>
<td>Sample 2.3 (10g/l)</td>
<td>11.164</td>
<td>35.972</td>
<td>2.44</td>
</tr>
<tr>
<td>Sample 2.3 (20g/l)</td>
<td>13.974</td>
<td>46.216</td>
<td>1.94</td>
</tr>
<tr>
<td>Sample 2.3 (30g/l)</td>
<td>15.552</td>
<td>51.700</td>
<td>1.93</td>
</tr>
</tbody>
</table>

**Material 1**

- 2.0 = untreated material, 2.1 = treatment with different amounts of softness agent, 2.2 = treatment with different amounts of smoothness agent, 2.3 = treatment with different amounts of stiffness agent

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**Sample 2.1 – softness agent**

**TS7:** Softness increases (amount of added softness agent doesn’t have an influence)

**TS750:** Roughness is positively influenced by the softness agent

**D:** The material becomes more flexible

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**Sample 2.2 – smoothness agent**

**TS7:** With an increasing amount of smoothness agent, the material becomes softer

**TS750:** The material becomes smoother with an increasing amount of smoothness agent

**D:** The material becomes more flexible

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**Sample 2.3 – stiffness agent**

**TS7:** The stiffness agent has a strong and negative influence to the softness

**TS750:** The material becomes rougher with an increasing amount of stiffness agent

**D:** The material becomes stiffer with an increasing amount
3. Application Examples

Optimization of the hand feel / touch by testing different additives in the textile converting

### Material 1

3.0 = untreated material, 3.1 = treatment with different amounts of softness agent, 3.2 = treatment with different amounts of smoothness agent, 3.3 = treatment with different amounts of stiffness agent

<table>
<thead>
<tr>
<th>Sample</th>
<th>Real softness TS7</th>
<th>Roughness TS750</th>
<th>Stiffness D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample 3.0</td>
<td>10.140</td>
<td>30.585</td>
<td>3.40</td>
</tr>
<tr>
<td>Sample 3.1 (10g/l)</td>
<td>8.666</td>
<td>27.570</td>
<td>3.80</td>
</tr>
<tr>
<td>Sample 3.1 (20g/l)</td>
<td>8.083</td>
<td>29.559</td>
<td>3.76</td>
</tr>
<tr>
<td>Sample 3.1 (30g/l)</td>
<td>8.083</td>
<td>29.439</td>
<td>3.76</td>
</tr>
<tr>
<td>Sample 3.2 (10g/l)</td>
<td>7.159</td>
<td>21.587</td>
<td>4.25</td>
</tr>
<tr>
<td>Sample 3.2 (20g/l)</td>
<td>8.254</td>
<td>20.863</td>
<td>3.90</td>
</tr>
<tr>
<td>Sample 3.2 (30g/l)</td>
<td>9.209</td>
<td>23.539</td>
<td>3.91</td>
</tr>
<tr>
<td>Sample 3.3 (10g/l)</td>
<td>10.641</td>
<td>47.771</td>
<td>2.22</td>
</tr>
<tr>
<td>Sample 3.3 (20g/l)</td>
<td>12.898</td>
<td>66.021</td>
<td>1.73</td>
</tr>
<tr>
<td>Sample 3.3 (30g/l)</td>
<td>16.505</td>
<td>83.278</td>
<td>1.38</td>
</tr>
</tbody>
</table>

**Sample 3.1 – softness agent**

TS7: With an increasing amount of softness agent, the real softness can be influenced, but no further improvement from 20 – 30g/l

TS750: Smoothness increases if softness agent is added

D: Material becomes more flexible

**Sample 3.2 – smoothness agent**

TS7: Real softness is positively influenced by the smoothness agent

TS750: Smoothness increases, the best result can be received at 30g/l added smoothness agent

D: Material becomes more flexible

**Sample 3.3 – stiffness agent**

TS7: Material becomes harder with an increasing amount of stiffness agent

TS750: Material becomes rougher with an increasing amount of stiffness agent

D: Material becomes stiffer
4. Conclusion

The TSA measurement results show the following:

- The same additive is not similar effective for different fabrics (different fibers)
- An additive which is supposed to influence one parameter (e.g. softness agent shall increase the softness) does also have an influence to the other parameters
- An increasing amount of an additive does not necessarily mean, that the quality of the targeted parameter increases in the same way

This means that with the help of the TSA:

- The best possible additive for a specific fiber mix can be defined
- The influence of an additive, to other parameters than the targeted one can be evaluated
- The point of saturation can be defined

The example shows, that with the help of the TSA:

- The R&D work can be optimized and be more targeted
- The process can be optimized in terms of: 1) choosing the right chemicals (chemical mix) and 2) defining the right amount that need to be added to reach the targeted quality and to optimize the chemical consumption
Thank you!

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