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New Measurement **System for Inline** Basis Weight Monitoring

Clean millimeter, wave-based system targeting synthetic nonwovens showing market potential.

N. Deferm[1], T. Redant[1], F. Cloppenburg[2], T. Gries[2], W. Dehaene[1], P. Reynaert[1]
1: KU Leuven, ESAT-MICAS, Leuven, Belgium; 2: Institut für Textiltechnik (ITA), RWTH Aachen, Aachen, Germany

Measuring and controlling the basis weight of nonwovens during the production process is essential for the quality of the nonwoven and the economics of the production line. State-of-the-art measurement tools include x-ray or beta-emission based sensors which require special licenses depending on the sensor. This article presents a new method using millimeter waves that can be used especially for nonwovens with synthetic fibers.

The cost structure of the production of nonwovens is mainly determined by the raw materials for production of the fibers. This strong economic drive forces producers to install basis weight measurement systems. An important set of basis weight measurement techniques rely on radioactivity. Two common methods are generally applied—beta-emission based sensing devices [1, 2] and X-ray based sensing devices [1, 3]. Both sensor systems typically come with a high cost-of-ownership related to its usage. Although X-ray is a cleaner technology than beta-emission, it requires special licenses when applied for high-mass nonwovens basis weight sensing. Voltages above 5 keV typically require specific licenses [4, 5, 6]. The European Commission periodically updates its Basic Safety Standard Directives [7], forcing companies to look for non-nuclear (and non-radioactive) alternatives.

This release introduces a new industrial measurement technique to determine the basis weight of nonwovens. The millimeter wave measurement system is installed inline for continuous basis weight monitoring of nonwovens during the production process. The system can also be used for quality inspection. Basis weight control systems adapt the machine settings based on the measured basis weight in order to gain stable basis weight in machine and cross-machine direction. The following paragraphs discuss the capabilities and performance of the measurement system based on various nonwoven test materials.

1. Broad range of nonwoven samples

Measurements have been carried out on various basis weights of Freudenberg's Evolon Polyamide-Polyester fiber-based nonwovens and polypropylene nonwovens from two different manufacturers. Evolon is a microfiber nonwoven produced by splitting a PET-PA bicomponent segmented pie filament using a high pressure water entanglement. Result is a microfiber nonwoven that is used in several technical applications such wipes, linens and covers suitable for allergy sufferers, sound absorption and technical packagings [8].

2. Millimeter wave basis weight measurement

The new basis weight measurement technique is based on the transmission of millimeter wave signals (electromagnetic signals with wavelengths ranging from 1mm to 10mm) through the nonwoven material. The system analyzes the differences in wave properties, caused by traveling through the material, between the transmitted and received electromagnetic wave. Fig. 1 schematically shows the measurement principle.

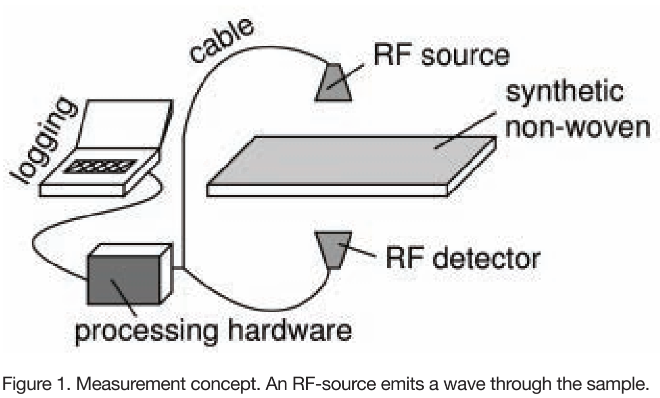

Figure 1. Measurement concept. An RF-source emits a wave through the sample. The RF-detector analyses the received signal and calculates the basis weight.

3. Basis weight profile visualizations

The measurement system is capable of visualizing the basis weight profile of any of the considered nonwoven sample material in two dimensions. Figure 2 shows the basis weight profile of three nonwoven samples with different basis weights. the Evolon samples, composed of 50% polyamide and 50% polyester, were placed side by side and scanned by the measurement system.

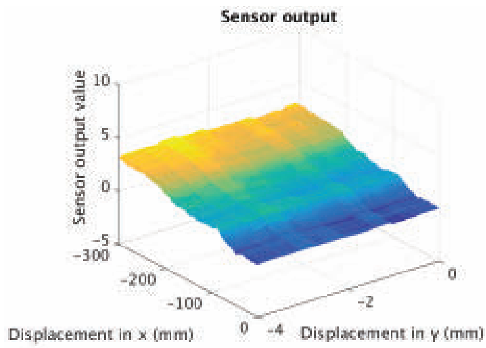

Figure 2. Visualization of the basis weight profile of 3 Evolon samples with different basis weights.

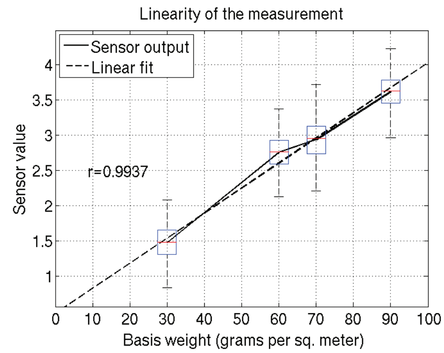

Figure 4. Linearity of the measurement for mid-range basis weights. Non-linearities are related to variations in the sample's basis weight, but also related to the manual handling of the samples, causing variations in the sample's bending and stress conditions.

4. Linearity

Based on the measurements on 2 sets of samples, the device's linearity has been tested. The first sample set has been composed of a 100% polypropylene nonwoven (manufacturer 1) stacked fibers with basis weights of 12, 16, 18, 20, 25, 35 and 50 gsm. Figure 3 shows the measurements on these samples as a result of manually feeding the samples to the system. For each nonwoven sample, 900 measurement points have been obtained. The duration of a measurement point is less than 13 microseconds. Each nonwoven sample corresponds to a different boxplot. The central mark of the boxplot is the median. The edges of the box are the 25th and 75th percentiles. The whiskers correspond to ±2.7 or 99.3% coverage. An excellent correlation coefficient (r=0.99265) between the linear fit and the measured data is noticed.

The second sample set has been composed of 100% polypropylene nonwoven (manufacturer 2) stacked fibers with basis weights of 30, 60, 70 and 90 grams per square meter. Figure 4 shows the measurements on these samples. For each nonwoven sample, 4000 measurement points have been obtained.

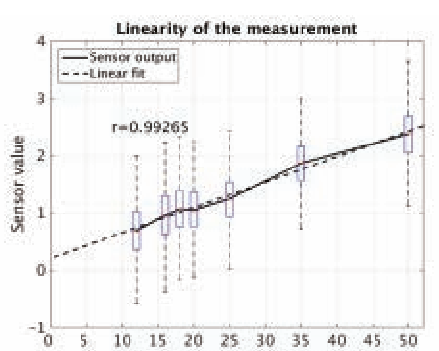

Figure 3. Linearity of the measurement for low-range basis weights.

5. Extended range

A polypropylene nonwoven of 90 g/m2 has been folded to create a set of: 90, 180, 270, 360 and 540 gsm. The outstanding ratio between the 540 gsm range and the measurement precision makes the technique particularly interesting for thick nonwovens. At last, the technique is expected to perform well up to 1 kgsm.

6. Precision

The measurements on the PP nonwovens revealed the precision. The boxplots of figure 3 reflect single measurements. Theoretically, the precision improves with the square root of the number of points over which measurements are averaged [9]. Figure 6 shows this theoretical tendency together with the obtained values from the measurements. A perfect fit between the measurements and the theory is achieved. This means that the mean standard deviation of 10.68 gsm for single shot measurements can be improved to 1.81 gsm after averaging more than 40 measurement points. Further signal-to-noise-ratio and precision improvement is possible when averaging is applied to a larger set of data points. A measurement precision of 1.81 gsm, is sufficient for nonwovens when a production precision of 10 gsm is targeted.

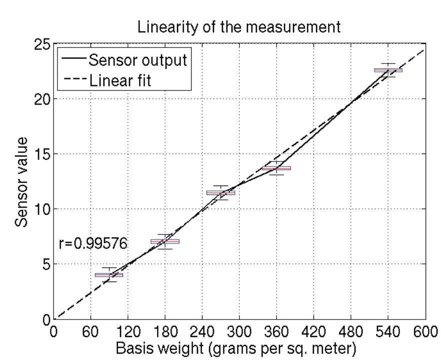

Figure 5. Linearity of the measurement for high-range basis weights.

7. Conclusion

In this article, a new measurement system for inline basis weight monitoring for nonwovens has been introduced. The presented system, based on a millimeter wave sensing technique, is a potential replacement for beta-emission and X-ray based systems,

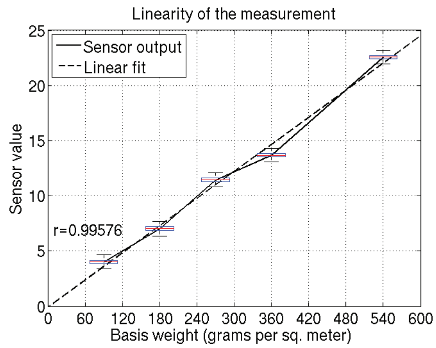

Figure 6. Impact of averaging on the precision of the measurement system.

but without the disadvantages that come with these radioactive-based measurement techniques. The broad range of applied test measurements have shown excellent performance in terms of measurement range (540 gsm) and precision (1.81 gsm if averaged over 40 measurement points), especially for higher basis weights. Both single-point as 2D basis weight plots can be created with the proposed system, making it not only perfectly applicable for inline applications, but also utterly suitable for lab testing. The measurement system is currently available for inline and laboratory feasibility studies. Complete inline and integrated installations are foreseen in the first quarter of 2016. More information: www.hammer-ims.com or email: info@hammer-ims.com. ■

[1] Mahlo, solutions for basis weight measurement of nonwovens: http://www.mahlo.com/nonwoven/weight/, last access: 31.08.2015; [2] Electronic Systems, solutions for basis weight measurement of nonwovens: http://www.electronic-systems.it/products/isosint-kh/, last access: 31.08.2015; [3] Electronic Systems, solutions for basis weight measurement of nonwovens: http://www.electronic-systems.it/products/prexision/, last access: 31.08.2015; [4] Royal Decree of 20 July 2001 laying down the General Regulation for the protection of the public, workers and the environment; against the hazards of ionizing radiation, as amended, http://www.fanc.fgov.be/GED/00000000/3400/3492.pdf, last access: 31.08.2015

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