Determination of moisture and thickness of leather using THz-TDS

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***Abstract*—We demonstrate that THz-TDS is novel non-contact technique useful for the determination of moisture and thickness of leather. The results are in good agreement with conventional techniques used in the tanning industry.**

I. Introduction and background

QUALITY control in leather is an important part of tannery industrial process. The moisture content of a leather hide determines its hardness or flexibility. Meanwhile, the leather thickness determines the application that will be given to it. That is why it is necessary to have efficient measurement methods for these two variables. Currently the techniques to measure these parameters are inaccurate and require several minutes which is incompatible with the timescales of a production line. In this work we demonstrate the possibility of using THz-TDS as a new non-contact technique and quasi-real-time to monitor these two parameters.

A. Methodology

Details on the THz-TDS setup can be found in [1]. In order to find the moisture content and thickness of leather we require the dielectric function of water and dry tissue. We use the double Debye model for the dielectric function of water. And the dielectric function of was determined by conventional transmission TDS [1]. Given these two dielectric functions we use the Landau-Lifshitz-Looyenga (LLL) effective medium theory in order to model the dielectric function of the combination of dry tissue and water. According to the LLL model

$$\epsilon_{mix}^{1/3} = a_w \epsilon_w^{1/3} + (1 - a_w)\epsilon_l^{1/3}, \quad (1)$$

where ϵ_{mix} is the complex permitivity of the mixture, ϵ_w is the permitivity of water, ϵ_l is the permitivity of dry tissue and a_w is the volumetric fraction of water within the sample. From the equation we can obtain the complex refractive index of the mixture $n + i\kappa = \sqrt{\epsilon_{mix}}$. With it it is possible to model the expected complex transmittance [1].

We used a least square algorithm in order to fit the theoretical transmittance and the experimental transmittance by varying the volumetric fraction of water (a_w) and thickness of the sample [1].

II. Results

Four samples with different moisture content and thickness were prepared and cut in half. One set was measured with conventional method and the other set was measured using the THz-TDS system. The theoretical complex transmittance was adjusted to the experimental complex transmittance by least square fit algorithm, as described earlier. The experimental transmittance and the fitted transmittance are shown in Fig.1

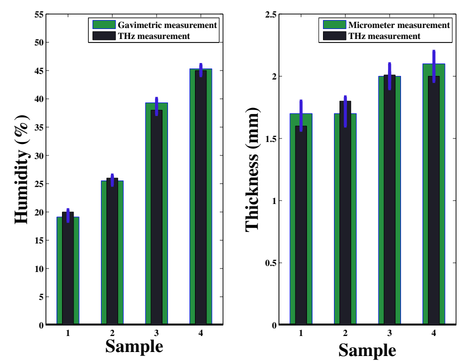

Fig. 1. Comparison of the results obtained between THz-TDS measurement and the conventional methods used in tannery.

There is an excellent correlation of both variables with mutual standard deviations between the measurements of 2 % for humidity and 0.15 mm for thickness

III. Conclusion

In this work we present THz-TDS as a useful non-contact technique to measure the moisture content and thickness of leather. The results are in good agreement with the conventional methods currently used in the tannery industry.

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References

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