

Labview in ultrasound plastic materials measurement

D. URSUTIU^a, C. SAMOILA^a, L. BALTES^a, M. TIEREAN^a, L. VEKAS^b, V. JINGA^a

^a "Transylvania" University of Brasov, Romania

^b Laboratory of Magnetic Fluids, Center for Fundamental and Advanced Technical Research, Romanian Academy-Timisoara Division, Timisoara, Romania

In this paper is proved the flexibility of LabVIEW (Laboratory Virtual Instrumentation Engineering Workbench) - graphical programming software – when it is used in connection with applications of ultrasound measurements in the field of plastic materials characterization. The ultrasonic measurement was carried out on plastic specimens with immersion method. In the first step the measurement was made in water with a transducer that generates a longitudinal 5 MHz wave. The same measurement was repeated in a magnetic fluid, water diluted. All of the measurements are oriented to obtain necessary data for the FP7- W2P Plastics project development. In Transylvania University laboratory, the measurement setup used was the EPOCH XT device from PARAMETRICS-NDT. The data can be saved on PC like normal TXT files and exported in Excel and LabVIEW. A preliminary application was developed to see the imported data in one Wave Form Graphic (WFG) or XY graph in LabVIEW. This data can be used easy now in idea of needs for future calculus and data computation. The obtained data will be used for the separation process of the polymeric waste immersed in a magnetic fluid.

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1. Introduction

For the proposed aim of separation of plastics waste using magnetic fluid separation who allows different immersion depth for different type of polymeric, it is of great importance the determination of the acoustical properties of polymeric materials (longitudinal ultrasounds velocity).

In the research, emission and reception of the acoustical waves were made with EPOCH XT instrument, and the first step was to adapt this device at LabVIEW requirements for determination of acoustical properties of the plastics.

The developed LabVIEW applications offer a better support in ultrasound materials measurements and characterization:

- data interpretation (characterization of the shape and height of the peaks, determination of the wave attenuation);
- control of the instrument for signal measurement (input/output data management; device setup and control);
- save the Data Base on PC (for future data computations).

The classes of polymers investigated in the research were presented in Table 1.

As we mentioned above, the measurements were made in water and in a magnetic fluid with Ms=130 Gs and 1/29 ratio dilution. This nano-magnetic fluids was produced by Laboratory of the Magnetic Fluids, in Timisoara-Romania (Table 2):

2. Experimental setup

As generator and receiver of the ultrasounds was used EPOCH XT (from OLYMPUS): with tunable square wave pulsing, selectable digital filters, gain range 0-110 dB, peak memory and peak hold, adjustable PRF, 0.01 mm measurement resolution, two gates with programmable alarms, etc. In the liquid medium (water or magnetic fluid) was placed one immersion sensor A310S-SU with the role of transmission /reception transducer (Fig. 1).

Table 1. Sample thickness.

Simple layered sample		Double layered sample	
Type	Thickness [mm]	Type	Thickness [mm]
PP	2.53	PMMA	10 + 4
HDPE	1.3	-	-
PS	1.53	-	-
PMMA	10 + 4	-	-

Table 2. Magnetic fluid properties.

Magnetisation Ms (Gs)	Particle density d (g/cm ³)	Temperature of measurements (°C)
97	1.088	29
130	1.132	29

The polymers studied are presented in the Table 3:

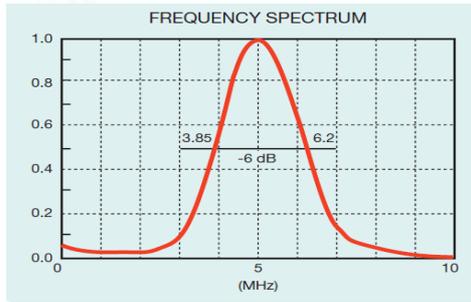


Fig. 1. Immersion sensor and his frequency spectrum.

Table 3. Sample properties.

Properties	SS-12:Midilena III-J800 Polypropylene (PP)	Hostalen GC 7260 Polyethylene (HDPE)	Styron 485 Polystyrene Resins
Melt flow rate (g/10min)	14-18	8	12
Dens. (g/cm ³)	0.905-0.917	0.960	1.050
VICAT soldering temp. (°C)	150	72	96

The measurement setup was made from PMMA and is shown in the Fig. 2, with the special positioning of the sensor and with the adjustable sample holder (on the right), at micrometric precision.

The input data, for all of the experiments were:

- Frequency = 5.00 MHz (for some measurements: 1 MHz to 7.14 MHz)
- Energy = 75 V
- Damping = 50 Ohms
- Filter = 1.5-8.5 MHz

For all the polymer samples was measured the thickness using a digital micrometer with a better precision like the thickness measured with the Olympus EPOCH XT device. We use these measurements results like input data for the ultrasound measurements.

The gates length was setup in a position so that to have the first expected peak inside of the first gate and the second expected peak inside the second gate. The ultrasound velocity was adjusted so that to obtain the sample thickness with 0.01 mm precision in upper-right corner (Fig. 3).

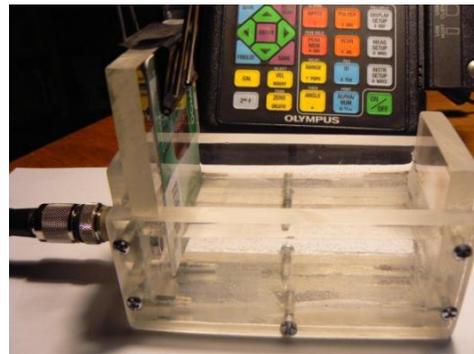


Fig. 2. Measurement tank and the sample holder and positioning system.



Fig. 3. EPOCH XT screen and signification of the values.

For extracting the measured data was designed a preliminary LabVIEW application, with the role of conversion for the EPOCH XT saved data file (one EXCEL file) and representation of data in on WaveFormGraph (WFG).

In the Fig. 4 are shown Remote Commands application and the developed LabVIEW program.

After this preliminary application we developed a second LabVIEW application. This application integrates the necessary Remote Commands and offer a full LabVIEW control of the Olympus EPOCH XT device (Fig. 5).

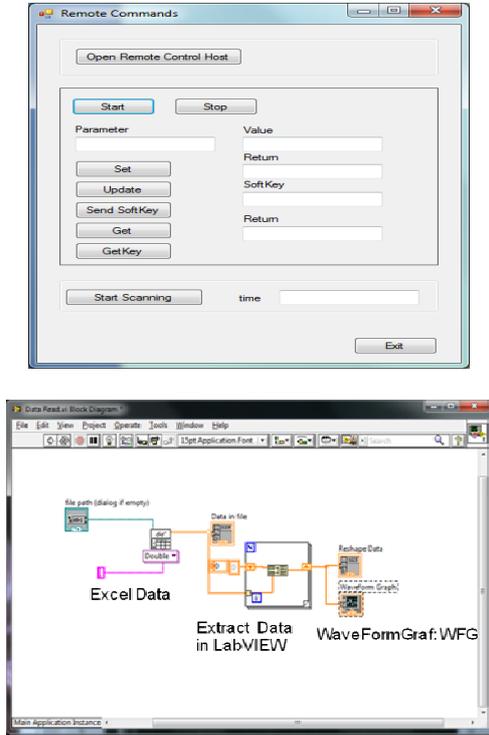


Fig. 4. Remote control panel and program for conversion, extract and WFG.

In the next figures we like to present some of the developed application facilities. This kind of LabVIEW development offer to the researcher's possibility to implement easy and fast new measurements and data computation.

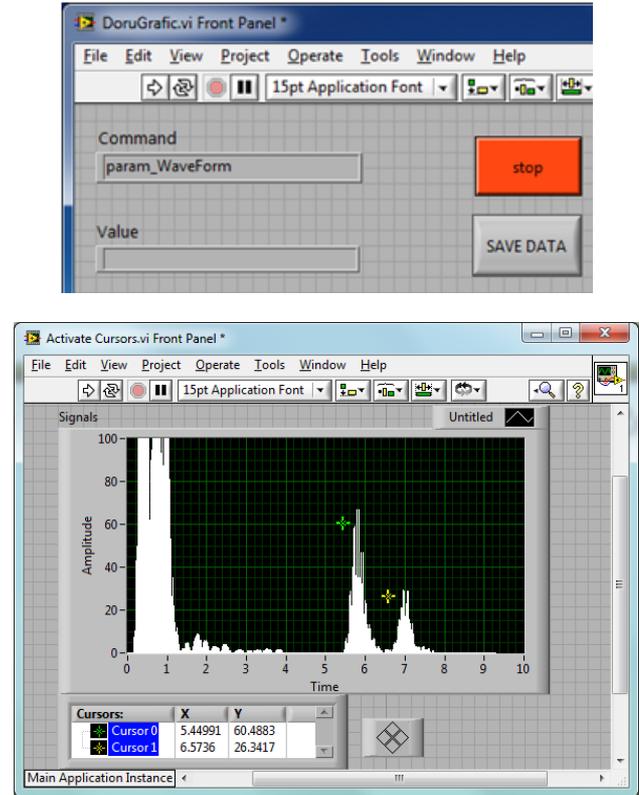


Fig. 6. Simple Data Save and Read (easy add cursors for discreet measurements).

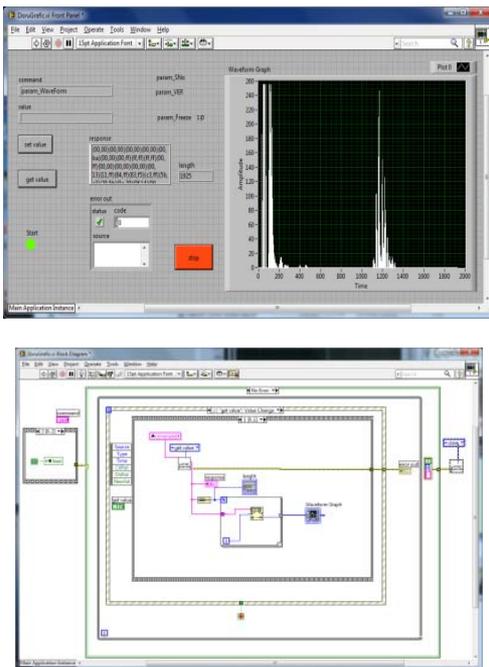


Fig. 5. Control program in LabVIEW (Panel on the left and Diagram on the right).

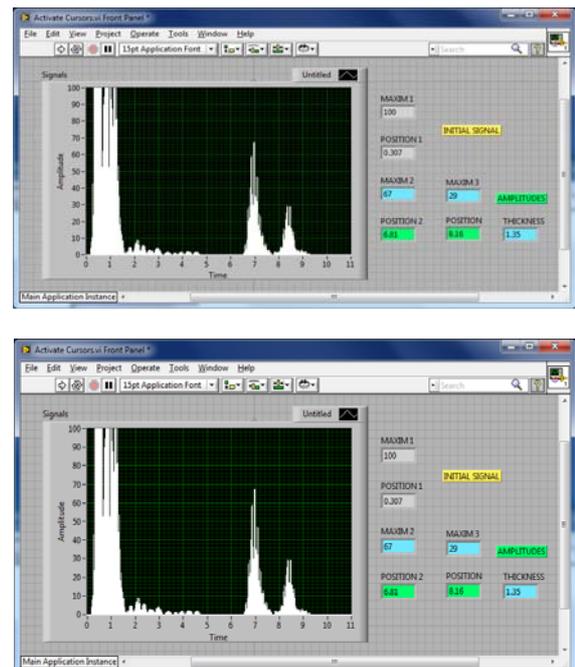


Fig. 7. Read and analyze the saved data (amplitude and thickness measurements).

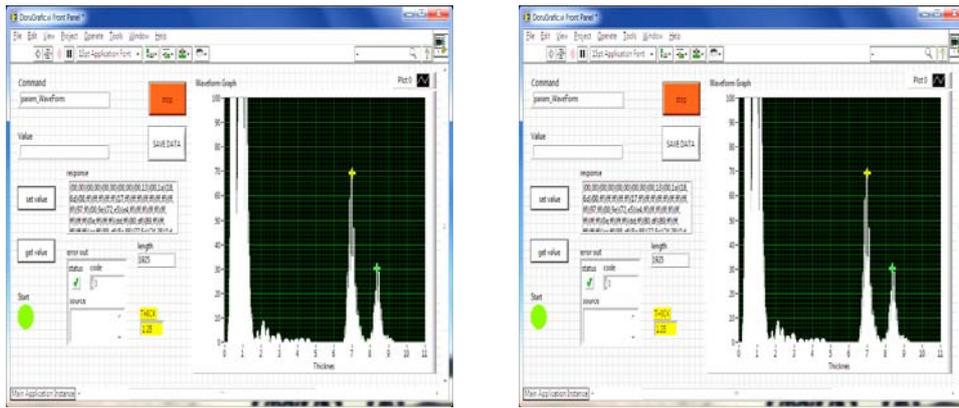


Fig. 8. Thickness (automatic) and Cursors (manual) measure: Polyethylene 1.35mm.

3. Results

For the experiments conducted in water, the synthesis of the measurements is concentrated in the Table 4 and the results of measurements in the magnetic fluid (1/29 ration dilution) were presented in the Table 5.

Table 4. Ultrasounds longitudinal sound velocity in water.

Type of polymer	Thickness (mm)	Longitudinal Sound Velocity (m/s) Experimental	Longitudinal Sound Velocity (m/s) Literature [8-12]
Hostalen GC 7260 Polyethylene (HDPE)	1.30 translucent	2324	2430 [8] 2241-2271 [10] 2460 [11]
III-Midilena SS-12:Midilena J800 Polypropylene (PP)	2.53	2478	2740 [8]
Styron 485 Polystyrene Resins	1.53 yellow	2204	2320 [8] 2290 [9] 2340 [11]
Plexiglas (PMMA)	10 transparent 10 white 4 yellow	2614 2471 2578	2750 [8] 2650 [12]

Table 5. Ultrasounds longitudinal sound velocity in magnetic fluid.

Polymer Type	Thickness (mm)	WATER Longitudinal Sound Velocity (m/s) Experimental	Magnetic Fluid Longitudinal Sound Velocity (m/s) Experimental
Hostalen GC 7260 Polyethylene (HDPE)	1.30 translucent	2324	2053
SS-12:Midilena III-J800 Polypropylene (PP)	2.53	2478	2654
Styron 485 Polystyrene Resins	1.53 yellow	2204	2243
Plexiglas (PMMA)	10 transparent 10 white 4 yellow	2614 2471 2578	2677 2521 2631

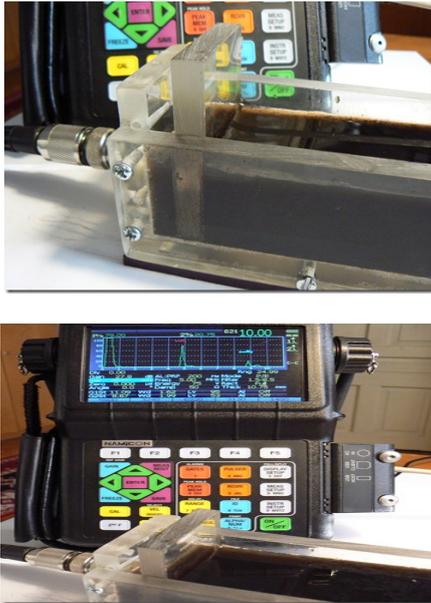


Fig. 9. Measurements in magnetic fluid.

Because one of the research objectives was determination of the frequency characteristics, the measurements were made in the interval: 1 MHz – 7.14 MHz. The obtained diagrams are shown in the Fig. 10, conclusion being that the 5 MHz is the best value for measurements.

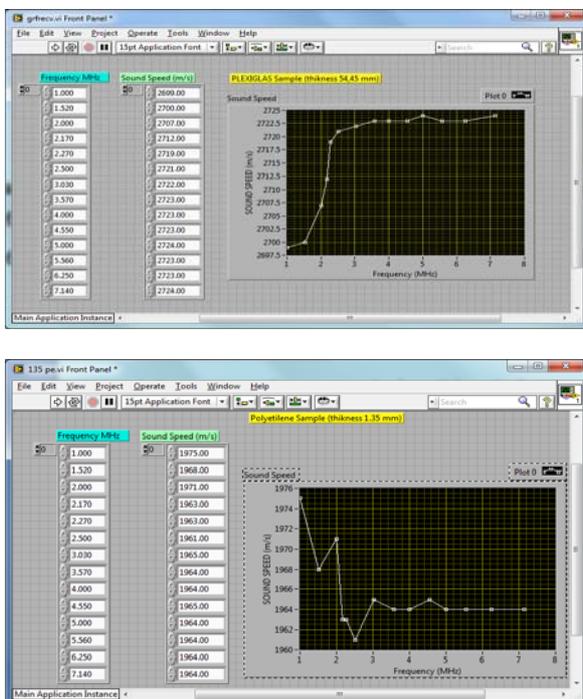


Fig. 10. Ultrasounds longitudinal sound velocity measured in the frequency range 1MHz – 7.14 MHz for: left PMMA and right HDPE.

4. Conclusions

1. OLYMPUS EPOCH XT instrument has been adapted for measurement of acoustic properties of plastic materials using LabVIEW environment;
2. Some LabVIEW application has been developed to:
 - enlarge the interpretation possibilities of the detected signals coming from ultrasound investigations;
 - make easier the input/output device control;
 - reduce the measurement time
3. Longitudinal ultrasounds velocity in different plastic materials has been determined both in water and in magnetic fluid with enough accuracy and well correlated with the literature;

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* Corresponding author: udoru@unitbv.ro