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VIRTUAL INSTRUMENTATION TO AID ELECTRICAL COMPOSITE BEHAVIOUR UNDER EXTERNAL STRESS STATE

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ABSTRACT
Particle reinforced composite materials can be characterized as having electrical conductive properties due to their fillers' material behavior. The paper aims to present a virtual instrumentation layout (Labview design) to aid electrical resistivity changes measurements for iron reinforced polymeric composite samples subjected to an external stress state. A LabJack U12 acquisition board will aid the implementation of the measurement data acquisition.

Keywords: particle, polymer, composite, electrical, properties, stress, state.

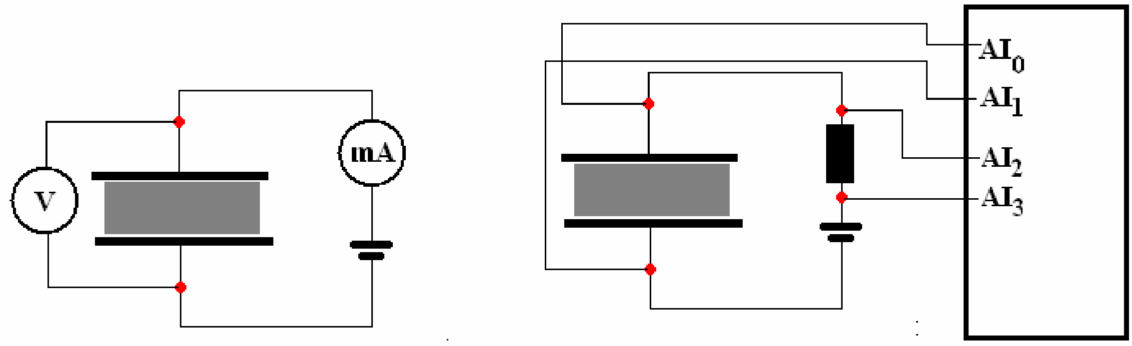
1. INTRODUCTION
Scientific literature in the field of composite materials, especially the polymeric particle reinforced ones lack in experimental data concerning their electrical properties. A deep survey reveals only few references with respect of theoretical models and experimental research [1], [2] and a direction to follow may arise especially if the samples under studies can be subjected to an external applied stress state.
Due to the extensive research focus on composite materials, as new emerging materials that proved to have a large spectrum of engineering application potential, polymeric particle reinforced composites proved to have a piezo-resistive behavior, the electrical conductivity of a composite structure having an insulating matrix depending on the particles': conductivity, volume fraction, dimensions, aspect ratio and their distribution in the matrix mass [4]. With respect to the latter, filler distribution in the structure is greatly influenced by the composite manufacturing method.
The herein paper focuses on metallic particle (Fe particles on different sizes – 100, 160, 200 μm respectively) embedded into a polymeric matrix material (epoxy resin) with the aim of retrieving an electrical parameter, namely resistivity in order to characterize the conductive nature of the composite samples.
As virtual instrumentation became an aiding tool to assist many experimental measurements, mainly due to its intrinsic property – to replace few measurements devices – the paper will present an attempt to gave up to the use of few classical measurement devices, such as ampere meter, voltmeter etc., actually to the "wires" an try to replace them with a modern, easy to use environment. In order to implement the experimental concept developed with respect of the paper's subject a Labview 7.1 environment were used.

2. CLASSICAL EXPERIMENTAL DATA ACQUISITION

The classical experimental measurements of the electrical resistance involves the use of several methods such as the ampere meter-voltmeter choosen herein and schematically represented in Figure 1 (a).

The experimental measurements were carried out firstly by using the composite samples being into a so called “after manufacturing” and after subjecting to a reheating treatment states. The reheating process was carried at 200^0 C for stress state relaxing after the measurements with samples subjected to an external applied load.

This set-up was then replaced with an acquisition board in order to aid the implementation of a virtual instrumentation layout concept. As can be seen in Figure 1 (b), the LabJack U12 acquisition board allows the measurements of electrical voltage with the aid of AI_0 and AI_1 channels, whereas the AI_2 and AI_3 channels are being used to aid the measurement of electrical intensity.



(a) (b)

Figure 1.Schematic classical ampere-voltmeter measurement layout (a). Schematic acquisition board aided measurements (b)

3. VIRTUAL INSTRUMENTATION LAYOUT AND DATA ACQUISITION

The experimental data retrieved during the measurements with the aid of the acquisition board are being processed by the use of an virtual instrument developed using the Labview 7.1 programming environment.

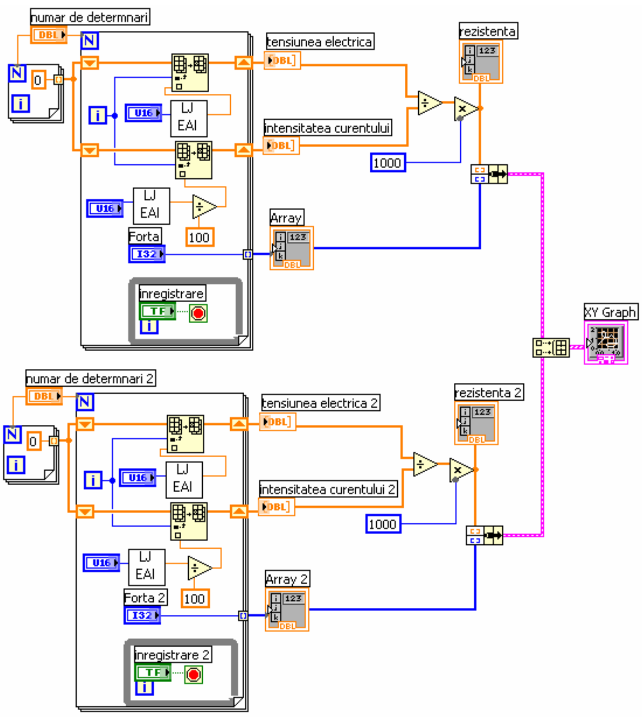
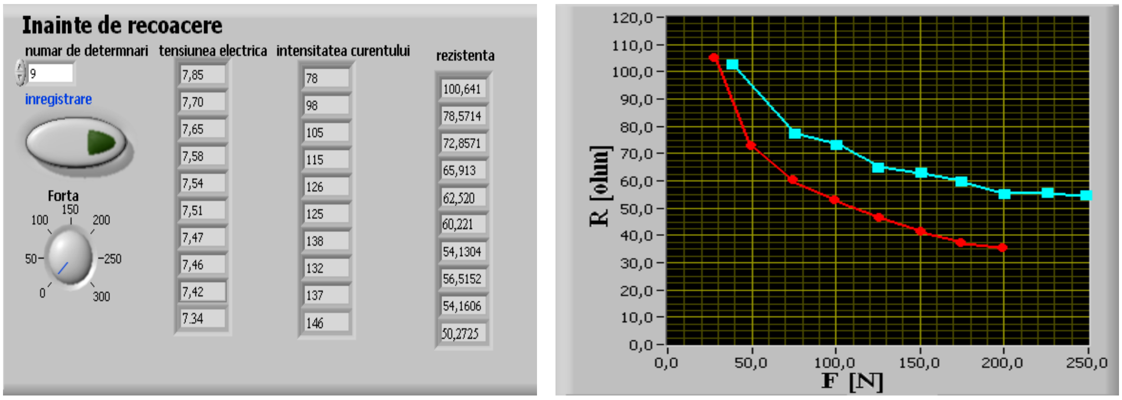


*Figure 2. The *.vi diagram window conceived for experimental data acquisition and processing steps*

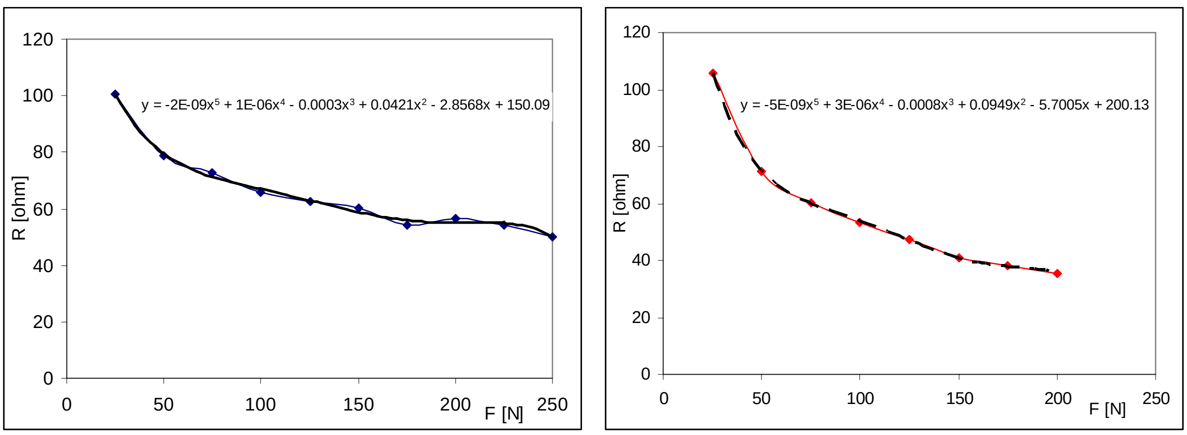
As can be seen in the Figure 2, that represents the diagram window, the signal acquistion process is divided in 2 individual execution structures – one for the composite samples subjected to a known external applied load, an the other for the same sample after a reheating treatment applied to releaf the internal stress acquired during the previous stage.
As can be seen, for each of the data acquisition structures a **for** loop was used. The acquired values from the acquisition board are being read into the program using the **eanaloginput.vi** function that allows the connection of a control to the **channel** terminal. The function output is being connected to the **new element** terminal of the **replace array** function**.** The experimental data are being saved into a matrix, for each values recorded at the AI_i (i=1,4) channels, representing the voltage and intenstiy values, respectively.
The **for** loop contains the program sequence necessary to build up the vector with the values representing the applied external load. The values corresponding the external force and to the resistivity (a simple formulae was inserted in the structure) will pass through the **bundle** from that will be plotted using the output element **XYGraph.**



(a) *(b)*

Figure 3. The application front panel window (a) and experimental data plots (b)

Figure 3 represents the front panel of the application containing one of the structures for experimental data acquisition as well as the experimental data plots – the blue curve (the higher values) corresponds to the values for the sample subjected to different external loads whereas the red curve corresponds to the values measured for the same composite sample (70 % Fe particles, 100 μm particle's size, embedded in an epoxy resin) but after the reheating treatment applied for internal stress relaxation.
In figure 4 are being plotted the experimental values retrieved and processed from the classical measurement set-up used to measure the electrical properties of the particle reinforced polymeric composites manufactured by the authors using a self-developed manufacturing technology.



(a) *(b)*

Figure 4. Experimental data plotting retrieved using the classical measurement set-up and particle reinforced polymeric composite sample before (a) and after (b) and applied reheating treatment

The virtual instrument can be further developed to address other types of materials having an electrical conductive nature as well as to measure their magnetic characteristics, if any. Material classification can be further implemented in the overall structure, these ideas being under further development by the authors of herein paper.

4. CONCLUDING REMARKS

Development in material science is naturally accompanied by "changes" on classical measurements methods and eased by the advent of tools more intuitive for engineering applications than standard programming techniques.

One of these tools is the Labview programming environment that combined with the portable and versatile hardware it opens the door to field as well as laboratory applications. One need only to carry a PC with multiple virtual instruments instead of several dedicated expensive devices each one appropriate to troubleshooting an error appeared during the performed task.

The virtual instrumentation implemented herein was developed as a natural consequence of easing the measured data acquisition and processing. With respect of data acquisition the previous are applied, whereas the data processing a simple structure replace a time consuming process of calculus and plotting.

5. REFERENCES

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