Computer Based Equipment for Measuring of Limited Deformation

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Abstract - **In this present work the new method for measuring of sheet metal´s deformations is described. It is based of the thin film resistive sensors and direct communication of the measured results between sensors and personal computer. The final calculations in Excel software are given.**

Key words -**thin film resistor, plastic deformation, resistive sensors, microcontroler.**

I. INTRODUCTION.

Measuring of the deformation parameters in the sheet metal forming is of a great importance for the knowledge the behavior of such materials. It is done using mechanical apparatus for observation of the deformation. This is spherometer in the help with the deviation of the sheet from flat to sphere could be registered (Fig. 1).

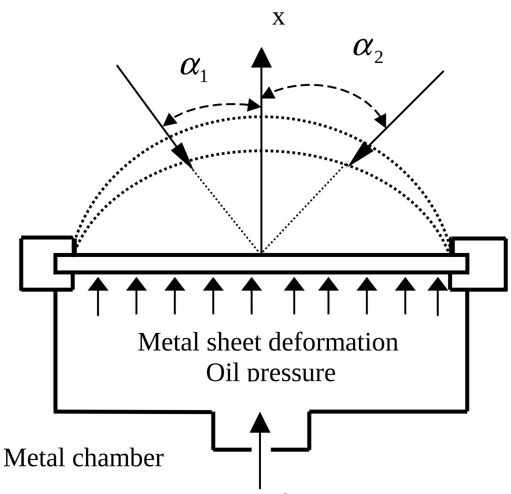

Fig. 1. The schematic picture of the mechanical device and measuring points.

The base of the method is three-dimensional stretching of the thin metal sheet under pressure until its destruction [1, 2].

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The disadvantages of the method are:
- visual observation;
- low accuracy (about 1*mm*);
- measuring the final destruction results only;
- lack of the dynamic results (time dependence).

To avoid that, the improvement is proposed using resistor sensor for movement and computer based calculation.

II. DESCRIPTION OF THE MEASURING PART.

A. Construction and technology of the sensors.

The resistive sensors used in this work are prepared by

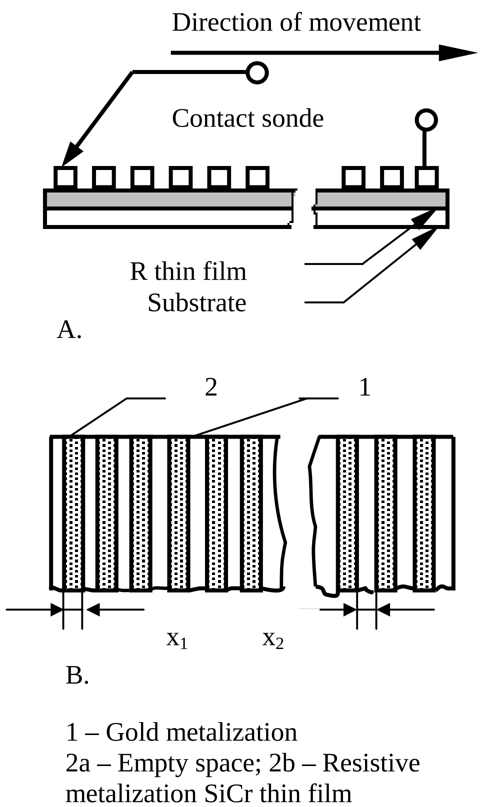

Fig. 2. The cross section (A) and topology (B) of the resistive sensors.

conventional thin film technology. They are two types – 100*ohms* resistor network and matrix with “zero” – “infinity” resistors (Fig.2). For the first type thin sichrom (SiCr) resistive film is used with nickel/gold final metalization [3].

The sizes of the resistors are length $50-100\mu m$ and $1000\mu m$ width. In this situation the sheet resistance (R_S) of SiCr film must be $1.0-2.0 kohm/sq$.

The second resistive sensors are prepared using standard nichrom – nickel – gold metalization [3]. In this case the sheet resistance of Ni – Cr film is not important because it acts as an adhesive under layer for Ni - Au films.

In the all experiments ceramic and crystallized glass substrates are used – Polycor and Sytal. The main parameter of the substrates is in roughness better than standard $20nm$. The TCR of the resistive films is about $\pm 100\, ppmk^{-1}$ which is sufficient enough for these applications.

The patterns of all sensors are produced using conventional wet etching process with positive photo – resist AZ 1350 H. The resistors of the first type are adjusted to the nominal values of $50ohms$ or $100ohms$ ohms using electric - spark trimming process.

B The method of measurements and computer based system.

As it is shown on Fig. 2 the resistive sensors are two types:

- serial network with fixed resistor $50/100ohms$;
- parallel network with R_0 and R_∞ resistors (Fig. 3).

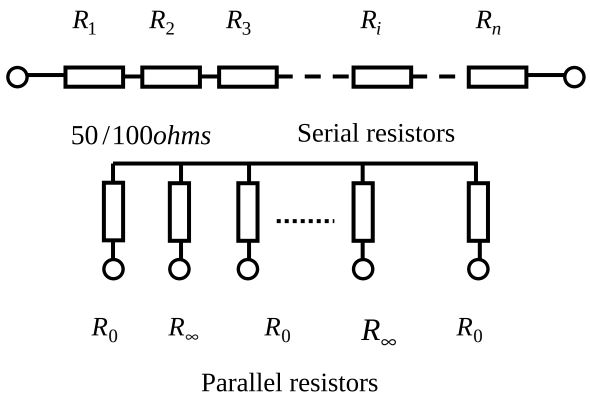

Fig. 3. The equivalent circuits of the resistive sensors.

The philosophy of the measurement is next. When the sonde moves following the material deformation, it contacts consecutively the gold pads with low resistance. In this situation it can be registered increasing values of resistance with $50/100ohms$ steps (first type) and series of “zero” – “infinity” resistors (type two). Fixing these values in time, the deformation parameters could be written and calculated dynamically and statically (last observation). The accuracy is plus minus $50ohms$ or $100ohms$ depending on the dimensions of the sensors.

The total calculation of dates is done by computer system (Fig. 4).

The procedure is as follows [4, 5]:

- synchronization of the beginning of the process deformation – measurement;
- counting and switching the sensors´ dates by microcontroler via METEX ohmmeter to PC;

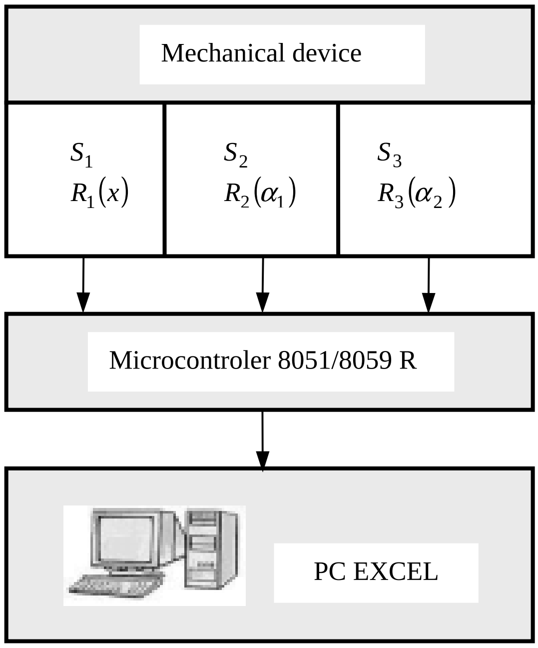

Fig. 4. Block diagram of computer based method for spherical measurements.

- final acceptance and calculation of the results using EXCEL.

III. CONCLUSIONS.

The experiments show that the sensors have some advantages and disadvantages. Firstly, for all types the accuracy is better than visual observation and there is a possibility for dynamic (time dependence) measurements

The first type of sensors has strictly written values but preparation is complicated. The second type have only two position R_0 and R_∞ but the number of counting the changes must be registered in time. As a result the improvement of connection between mechanical test and computer calculation is done.

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