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Rejection of potentially defective CMOS IC

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Abstract – In this paper, some measures of increase of operational reliability of microcircuits at stages of manufacture and operation are examined.
Keywords: microcircuits

I. INFLUENCE OF GAMMA IRRADIATION AND ANNEALING ON SENSITIVE PARAMETERS IC 564LE5

Research was spent on IC current manufacture on the algorithm submitted on fig. 1. Results on change sensitive parameters have shown, that the most changing parameter at an irradiation is the current of consumption, and, it grows almost by one order more at potentially defective IC. However, at room temperature there is a fast decrease of values with gradual returning to reference values after an exhibitor. From the analysis of experimental results it is possible to draw the following conclusions:

1) Measurement of values of a current of consumption IC 564LE5 during 1 hour after an irradiation a doze 105 R allows to classify them on suitable and a spoilage (to suitable IC at what the current of consumption does not exceed shop norm – 60 nA concern);

2) Relative changes on other parameters are less than on a current of consumption (though values are higher);

3) At room temperature in day of return to reference values of parameters it is not observed;

4) the annealing at temperature 150-180^{0}C within several hours does not return all parameters to reference values while annealing at 350^{0}C during 0,5-1 hour returns all parameters to reference values (including at defective).

The accelerated tests investigated IC at temperature 125^{0}C and a pulse feed within 1 month have shown, that their parameters have remained within the limits of norms THAT.

II. REJECTION OF POTENTIALLY DEFECTIVE IC ON PLATES

Rejection of potentially defective IC on plates after an irradiation is more expedient. However, today it represents some industrial difficulties connected to necessity of the control of parameters of structures within several hours - day. At plenty of plates it is possible to use the express train of sample, but it reduces reliability of rejection.

The researches which have been carried out on algorithm, submitted on fig. 2, have shown, that after ETT and the subsequent gamma irradiation relative changes of a current of consumption are much higher (2118 % - 1st part, 1192 % - 2nd part, 129O than % - 3rd part), than without carrying out ETT (parts 2 and 3) while relative changes of a target current of a high level differ on 3,3 % (45,9 % - for 1st part, 49,2 % - for 3rd part). Annealing IC within 0,5-1 hours at temperature 350^{0}C returns parameters to reference values, but after carrying out again ETT the consumption current grows more at potentially defective IC. The annealing within 3 days at temperature 150^{0}C reduces values of a current of consumption (after ETT were checked once again) up to reference values of effective articles. It means that in one hour the annealing at temperature 350^{0}C for investigated IC was insufficiently for full restoration of parameters (system oxide - silicon remains unstable). It is possible to assume, that the CJ assembly (planting on the eutectic in the investigated case, hermetic sealing) results in mechanical pressure of a crystal which are added to internal pressure in oxide and on border oxide silicon. These pressures (voltages) are shown at temperature processing and gamma irradiation on changes of parameters. Gamma irradiation promotes display of deeper levels, and the annealing temperature to display at finest. As a result of gamma irradiation and the annealing there is an improvement of structure for one part of crystals and deterioration - for another which is potentially defective.

So:

1) Rejection of potentially defective IC can be carried out with the help of gamma irradiation and annealing and it’s better to make it on plates;

2) The temperature mode of manufacturing oxide substrate and the subsequent operations of manufacturing IC should be supervised well that it was as small as possible formed internal and mechanical pressure.

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III. REJECTION OF POTENTIALLY DEFECTIVE IC: A METHOD OF TEMPERATURE RISE AND SUBMISSION OF AN EXCEEDING PULSE PRESSURE ON THE TRUNK OF A FEED

In this section accelerated tests IC of memory 565RU1 and 556RT5 are examined. The problem of accelerated tests (UI) IC for EA developers is essential as refusals IC can't do without any financial losses (for example, in space objects).

Let's consider results of research IC of memory with the help of the forced tests thermal training with applying the increased electric loadings and the subsequent check of functioning in conformity about THAT.

At a choice of temperature of tests it is necessary to take into account the physical phenomena occurring in concrete tested IC, opportunities of the test equipment. The size of an exceeding pressure got out so that there was no breakdown (transitions) in oxide substrates and oxides of remembering elements. The conclusion has been made of the analysis of work IC 565RU1, that a mode at which all elements 565RU1 work practically, the mode of record is. The time of submission of an exceeding pressure is determined by the diagram of conditions (for 565RU1 on an input it should be equal 60-150 nanosecond, beginning from the moment of submission on input "CE" 12 B). Thus a pressure (up to 20 B), temperature (700^0C), and duration of an exceeding pulse (up to 700 nanoseconds) have been picked up. During tests it was supervised OUR IC 565RU1.

Displacement of bottom border OUR is typical of the majority investigated IC on UDD aside increases on 0,8 – 2 In, and on UBB changes are insignificant. At action of temperature 700^0C within 8 hours and amplitude 4 In from 70 investigated IC five did not begin to store an exceeding pulse "1", one - "0", one "0" and "1", one - was restored. At action of the same temperature and an exceeding amplitude pulse of 8 In within 24 hours 10 %, as well as in the first case have broken down 7 IC from 70, that is. The conclusion arises, that over 8 hours to maintain IC at 70^0C is inexpedient, that influence on size of an exceeding pulse in 4 In and 8 In do not differ. From investigated IC the set in 70 pieces which was exposed to temperature and electric influence within 140 hours per the same modes has been made. Any of them has not broken down, while from untried 70 IC for same time 6 pieces have broken down. The analysis failed IC has shown, that at the majority of them the dielectric is punched.

In conformity about OST IC of 556 series are tested at temperature 70^0C in a nominal mode 5 In within 168 hours. ETT it is carried out after "the burn-through" smooth crosspieces and it is directed on revealing restored the ENCORE. Features of construction of internal structures and programming ENCORE PPZU allow applying them the following technique which essence is considered on an example 556RT5.

The principal cause of the smooth crosspieces overgrowing in PPZU after programming is diffusion, accelerated at ETT in temperature and an electric field. If in a "reading" mode to submit exceeding pulses on the trunk of a feed 5B (duration of pulses is compared to duration of pulses of programming and frequency of their submission is determined by the diagram of conditions) the percent of crosspieces overgrowing considerably decreases. These ways of the accelerated tests are introduced in NIZEVT, NPO "Cascade", and MNIIPA. For ways of the accelerated tests MOS IC and bipolar PPZU it is received two copyright certificates.

It is possible to draw the following conclusions:

1) The accelerated tests 565РУ1 allow to assert, that under certain conditions ETT it is possible to speed up rejection of potentially unreliable IC;

2) Selection of temperature of the accelerated tests and exceeding pressure should be carried out in view of manufacturing techniques, design features and functioning IC;

3) Failure IC at the accelerated tests is connected, basically, with breakdown of poor made oxide.

IV. CONCLUSIONS

1. Gamma irradiation can be used for rejection of potentially defective CMOS IC with the help such sensitive parameters as a current of consumption, a target current of a high level, etc.

2. As for restoration of parameters after gamma irradiation it is necessary to use the annealing at temperature 350^0C for reduction of the formed volumetric and superficial defects and as this temperature promotes formation of inter-metallic compounds it is better to carry out rejection on plates. Besides, rejection CJ on plates allows saving a significant amount of cases.

3. The use of gamma irradiations for rejection of potentially defective crystals on plates is economically justified and does not worsen reliability CJ the ambassador annealing plates.

4. Forced tests CJ (with the help of rise in temperature and submission of an exceeding pulse pressure) can be used as a method of the accelerated rejection of potentially defective CJ, and, time of tests in comparison with ETT is reduced till 2-8 o'clock.

REFERENCES

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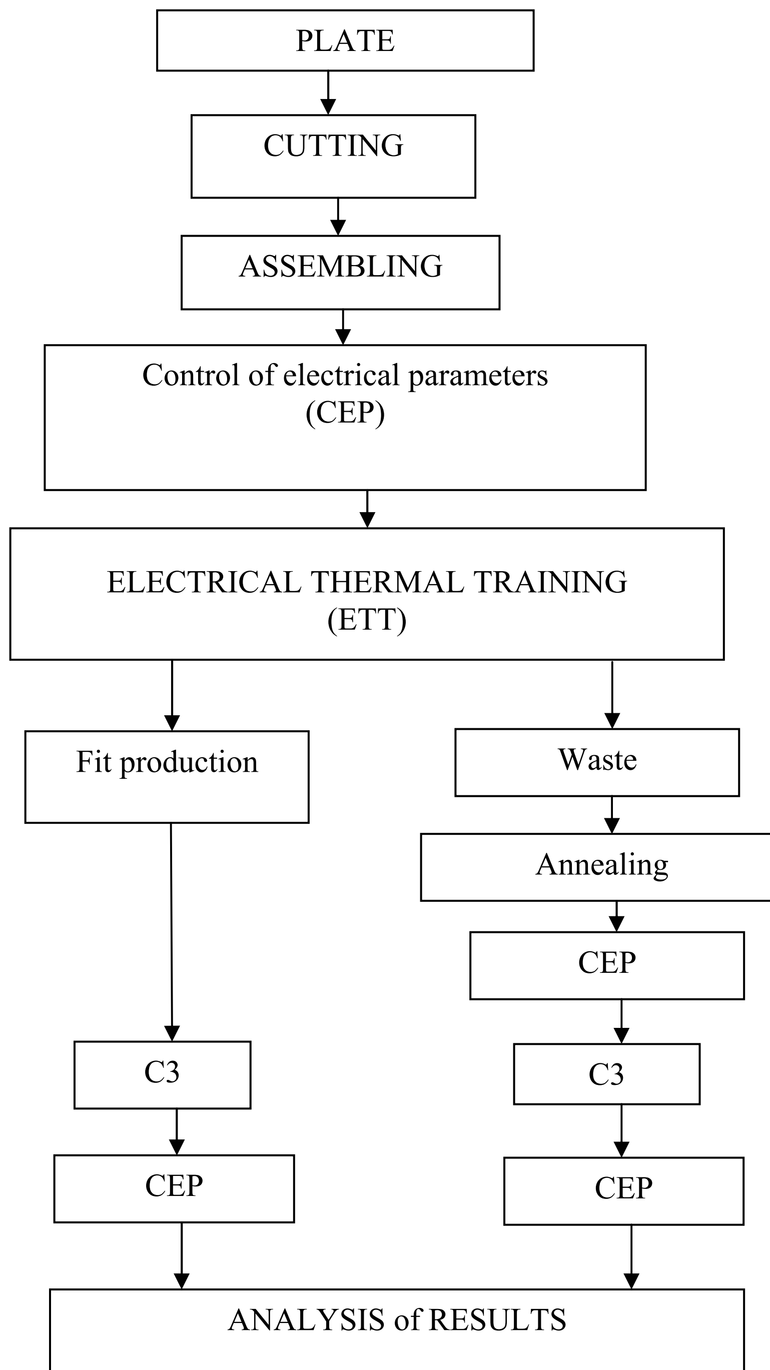

Fig 1. Algorithm of carrying out of research on influence of an irradiation on electro parameters IC.

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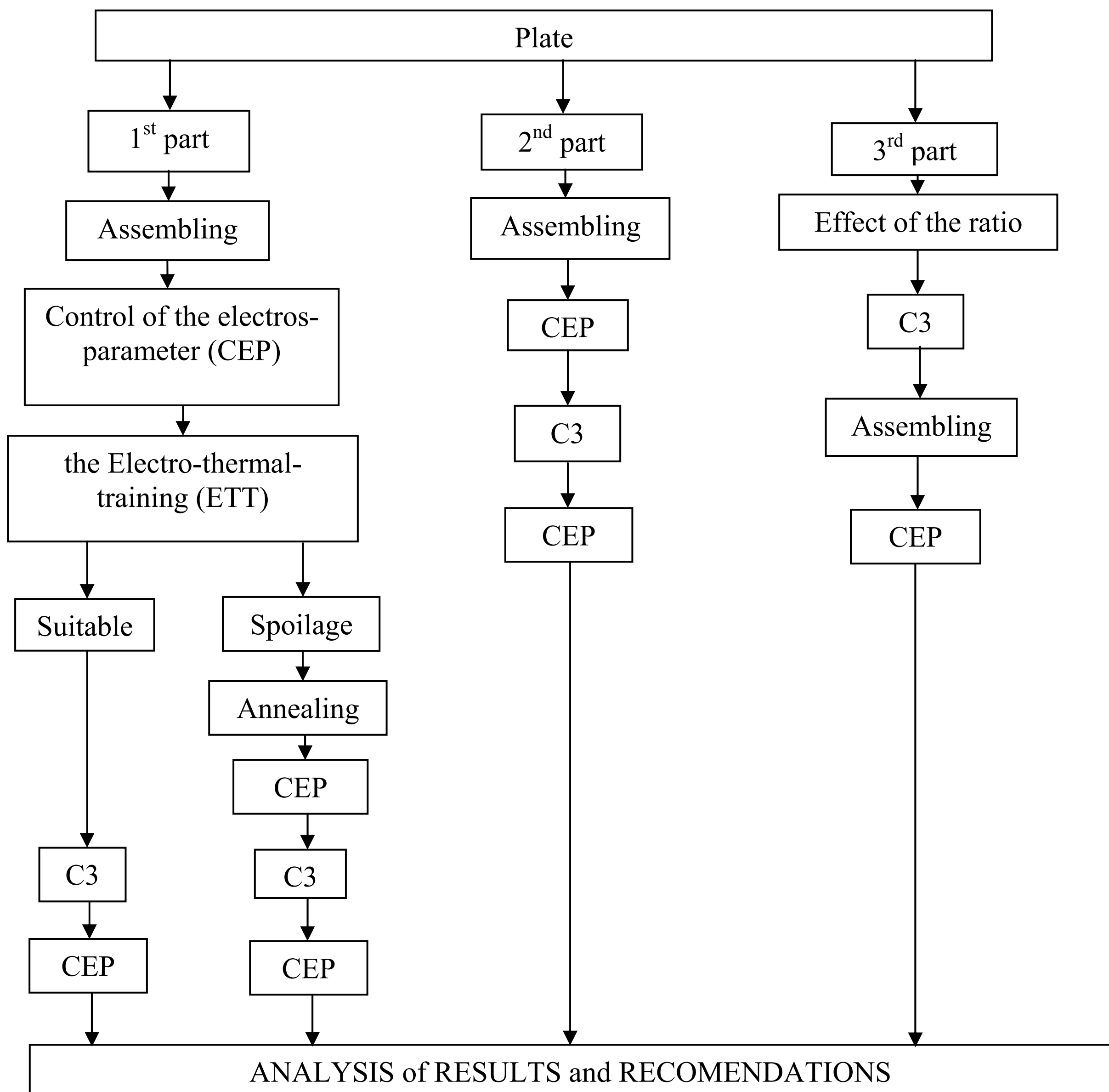

Fig. 2. Algorithm of carrying out of the comparative researches IC made of one plate

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