New Trends of BGA Soldering in Education

Martin Adamek, Jan Prasek and Michal Nicak

Abstract – **This paper deals with the problematic of modern soldering technologies and the implementation of new trends of modern soldering technologies into education process. It describes the possibilities of implementation of modern equipment in the education process, concretely in courses specialized to modern technologies of electronic circuits and systems. The possibilities of 3-D structures and BGA soldering using own prepared ceramic and organic based samples were presented. The samples with deposited solder paste using stencil printing techniques were assembled using Fritch microplacer and soldered using vapor phase soldering device Asscon Quicky 300. The final inspection of soldered joints was made using Ersascope special optical inspection device. Finally it was found that this process is suitable for practical education in the lessons of modern packaging and systems subjects.**

Keywords – E**ducation, BGA, Soldering 3-D packaging**

I. INTRODUCTION

Expansion of microelectronics technologies is very fast. Customers still want smaller and smaller components with higher performance. Therefore all producers develop new types of higher performance electronics components, which are smaller and which have higher density of integration, better cooling quality, lower weight and power consumption if possible. Of course the components price must be grateful. Main requirements on components design are easy assembly, packaging and interconnection. The package types, which are used in this time, are SOJ, SOIC, PLCC, QFP, etc [1]. Very progressive types of packages are for example Flip-Chip [2], CSP, Wafer-Level Packages, MCM and components of Grid Arrays type.

The Grid Array type components could be divided to pin array (PGA - Pin Grid Array) and ball array (BGA - Ball Grid Array) of terminals placed on the package body. The main advantages of BGA are high density of terminals, low-inductance leads and conduction of waste heat. Main disadvantages are difficult inspection and noncompliant leads. Because of leads noncompliance, a difference in thermal expansion Coefficient between PCB substrate and BGA may be problem [3], [4].

One of new trends is 3-D packaging. This type exploits the third dimension to a solution of higher integration and performance. Various types of 3-D structures exist or are developed.

An education on high schools and universities must be conformed to these new trends and new technologies, which are a base for new education methods. These methods must maximally demonstrate these new technologies and use new communication techniques and Internet to clearly explain and demonstrate given problematic. On the other hand the presentation and education of these new technologies must be easy-to-understand and affordably priced. Therefore the real components need to be substituted by dummy components or special test preparations.

The aim of this work is to show the possibilities of laboratory equipment usage in practical lectures for master's or bachelor's degree students from our university in the field of modern soldering technologies, especially in modern packages or 3-D packages assembly and soldering process.

II. BASIC IDEA

In case of BGA soldering it is possible to easily substitute the real BGA components by dummy BGA components, but the cheaper solution is the real BGA component substituting by a special test component, which is made from ceramic or PCB. This solution is optimal for soldering education. The second main advantage of this solution is possibility to utilize it for demonstration of new trends of 3-D packaging in education. Next advantages are low cost and easy implementation to practical laboratory education.

The process, when the bumps and leads are made in one step, brings next simplification. This simplification process was shown and optimized in [5], where the leads (bumps) were made from a solder paste, which is applied through a stencil by stencil-printing. It was found that the solder paste is possible to be applied to both parts (component, basic substrate), but leads quality is higher, when the solder paste is applied to component. The main advantages of this process in education are save of time (step of bump production is skipped) and low cost. Unfortunately the main disadvantage is less quality of assembly. Therefore this technology is unsuitable for many layers assembly.

III. DESIGN OF OWN TEST COMPONENTS

The test components, schematically shown in the figure 1, from other project [5] are possible to be used as a base for tests and usage in education. The test substrates shown in the figure 1 were made from ceramic using standard thick film technology and from PCB (FR4).

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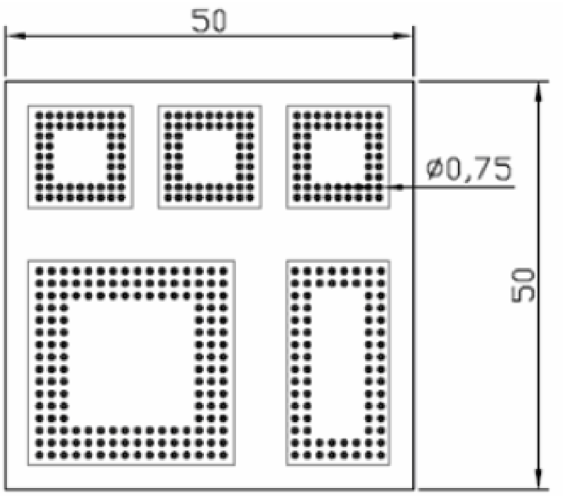

FIGURE 1: THE DESIGN OF TEST SUBSTRATE

IV. THE IMPLEMENTATION OF 3D-PACKAGING TO PRACTICAL LABORATORY EXPERIMENTS

The implementation of basic idea (3-D packaging and process, when the bumps and leads are made in one step) is simple. First step is fabrication of test components. The quantity of test components has to be sufficient for trouble free education process. It is expected that each test component will be destroyed during students' experiment in practical laboratory education.

Second step is the application of solder paste to substrates by stencil-printing. The sample of test components after solder paste application is shown in the figure 2. One of problems that can occur during solder paste application process can be a clogging of stencil holes, due to the necessity of thick stencils that are needed for the process of solder paste application. The stencil with thickness of 0.55 mm was used for testing. Various solder pastes were used for testing (Cobar S6M-XM3S, SHENMAO PF610, Cobar S9M-XM3S). In some cases the short circuit between terminals was observed. From the obtained results was from this point of view clear that the solder paste ESL EnviroFlo K545-39 appeared to be the best paste from all tested solder pastes.

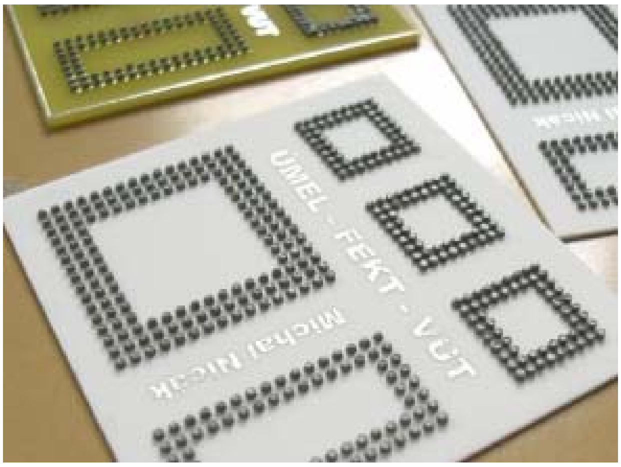

FIGURE 2: THE SAMPLE OF SUBSTRATES AFTER THE SOLDER PASTE APPLICATION

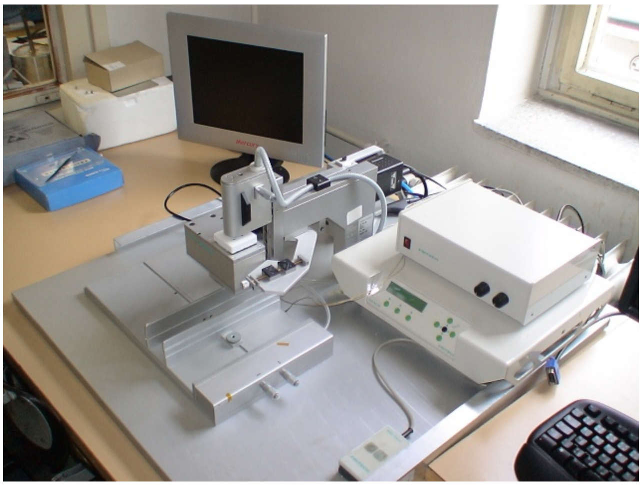

FIGURE 3: THE FRITSCH MICROPLACER

The substrates are completed to final 3-D structures by microplacer. The microplacer FRITSCH is used for assembling the substrates on the Department of microelectronics, FEEC, BUT. The microplacer FRITCH's photo is shown in the figure 3. This mikroplacer has sufficient position accuracy for the 3-D structures fabrication and for the BGAs assembly. The substrates with conducting paths must be placed first. Second, the BGA components or their substitutes are placed.

Last step is soldering process. The FRITCH device could be also used for reflow soldering in this case. For better demonstration, the vapor phase soldering is generally used. It represents the best solution for BGA components. Therefore it is good for designed type of 3-D structures. The vapor phase soldering is a method of soldering, when components are immersed in a vapor bath. Vapor's temperature is higher than the solder paste melting temperature. In this case, the main advantage is equable distribution of temperature across the soldered joint during the soldering process. In our case the device Asscon Quicky 300 with liquid Galden HT-230 is used. The real photo of Asscon Quicky 300 vapor phase soldering device is shown in the figure 4. The boiling temperature of Galden HT-230 liquid is 230 °C. The typical temperature profile used during the vapor phase soldering process is shown in the figure 5.

FIGURE 4: THE VAPOR PHASE SOLDERING DEVICE ASSCON QUICKY 300

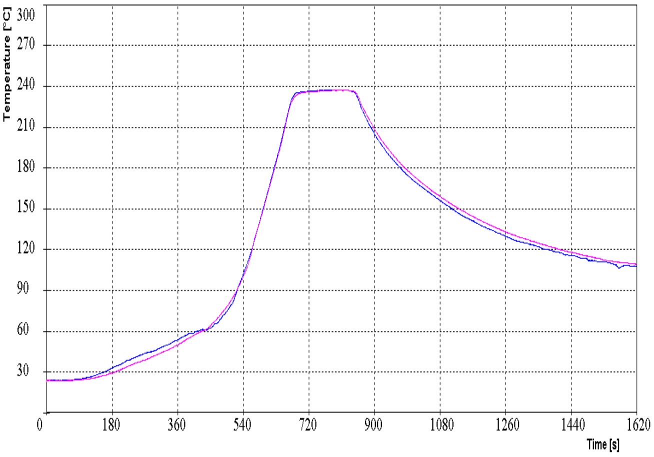

FIGURE 5: THE VAPOR PHASE SOLDERING TEMPERATURE PROFILE USED FOR EXPERIMENTS

The inspection of samples after soldering process is possible to be done by some optic inspection devices. Common optical devices are not suitable for optical inspection of modern packages. Therefore the special optical systems were developed for such purpose. One of the best devices used for optical inspection of modern packages is the device Ersascope from Ersa Company. The Ersascope device used in our laboratories is shown in the figure 6. This device was used for fabricated samples solder joints verification. The view of one of fabricated and soldered samples of 3-D structure obtained from Ersascope device is shown in the figure 7.

FIGURE 6: THE MODERN OPTICAL SYSTEM ERSASCOPE FOR FABRICATED SAMPLES SOLDER JOINTS VERIFICATION

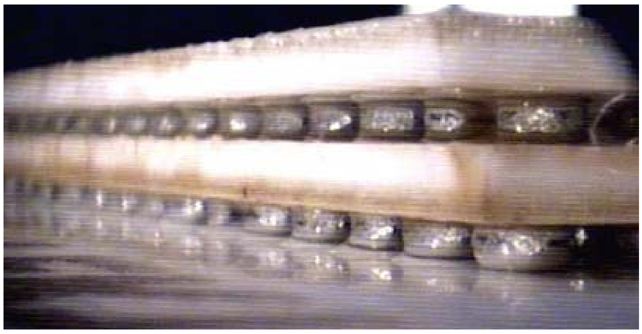

FIGURE 7: THE VIEW OF ONE OF FABRICATED SAMPLES OBTAINED FROM ERSASCOPE DEVICE

V. CONCLUSION

Expansion of microelectronics technologies is very fast. Therefore the implementation of new trends into the education process is needed. One of procedure of implementation of new trend in BGA soldering and 3-D packaging to education process was described in this paper.

The possibilities of 3-D structures and BGA soldering using own prepared ceramic and organic based samples were presented. The samples with deposited solder paste using stencil printing techniques were assembled using Fritch microplacer and soldered using vapor phase soldering device Asscon Quicky 300. The final inspection of soldered joints was made using Ersascope special optical inspection device.

It was found that process of modern packages soldering is suitable for implementation in students' practical education in the lessons of modern packaging and systems subjects.

ACKNOWLEDGEMENTS

This work has been supported by the Czech grant FRVS 2680/2009 *Modern technologies of electronic circuits and systems subject's exercises innovation* and by the Czech National Research Program's project 2E08051 *Research of methods and techniques for general public familiarization with a researcher work by information technologies*.

REFERENCES

[1] http://www2.okisemi.com/site/datasheets/pkgch1.pdf
[2] http://www.siliconfareast.com/flipchipassy.htm
[3] http://en.wikipedia.org/wiki/Ball_grid_array
[4] http://www.nexlogic.com/BGA-Packages.aspx
[5] M. Nicak. *Modern Packaging and 3d Systems.* Diploma thesis, Department of microelectronics, FEEC, Brno University of Technology, Czech Republic, 2009.