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KEKO EQUIPMENT

Keko Equipment NEWSLETTER

NO. 2 **NOVEMBER 2003**

KEKO EQUIPMENT

In the interplay of time and space opportunities and coincidences meet.
At this juncture the intermingling of knowledge and vision pursues happiness.
When experience and boldness look out for development, a path opens into the future.

insight

We are delighted to present our No.2 Newsletter, which will be issued in autumn once a year. Its goal is to present our company, a market situation, novelties, and trends in development as well as informing our present and potential buyers.

After issuing the first number, we acclimatised ourselves well to a new production area and plenty of novelties were carried out in our production programme.

The situation after the extreme year 2000 was stabilised in the last few years, which were sometimes not profitable enough, but that was the problem that all the manufacturers of the components and equipment shared.

Despite the drop in sales, we managed to develop new machines and new production lines and therefore we are well prepared for the better times, which have already begun. The strategy of the company was to start to cooperate with other fields of business, above all with the car industry. The fact that we can produce LTCC, piezo elements and similar products enables us to expand our range of buyers, to find new markets and it will make possible the equal division of market oscillation as well.

We are glad that our show room is well visited. We have made a lot of tests and it proves to be a good investment, which pays. You are invited to visit us in future as well. In this way we will be able to assure that the equipment bought in our company is suitable and that will entirely serve your needs.

I would like to thank our agents all over the world. They are our great help and a constant contact with the buyers. A good support is welcome also in the times when the market situation is a little bit worse, but on the other hand, it offers us more time for the development and preparation of new products.

I hope that you will find our newsletter useful. If you have any suggestions for the content of future issues, we will be glad to hear from you.

Tone Konda, General Manager

Development Strategy

Jože Štupar, Technical Director

Keko Equipment is a manufacturer of a wide spectrum of multi-layer passive electronic components. Our development activities are directed to manufacturing of the machines for a mass production, as well as to machines for a small number production of components. Our strategy is based on two key areas: the manufacture of machines for manufacture of classic components (condensers, varistors...) and for the manufacture of new components, like LTCC.

Our aim at manufacturing traditional, that is classic equipment, is to improve our machines and make them perfect. Our equipment should provide our buyers with even better, faster and more competitive production and therefore we search for new technological solutions. In the field of classic components we would like to develop

machines which will be able to manufacture multi-layers with the greatest possible number of layers, from 500 to 1000, which is a current demand in the manufacture of MLCC.

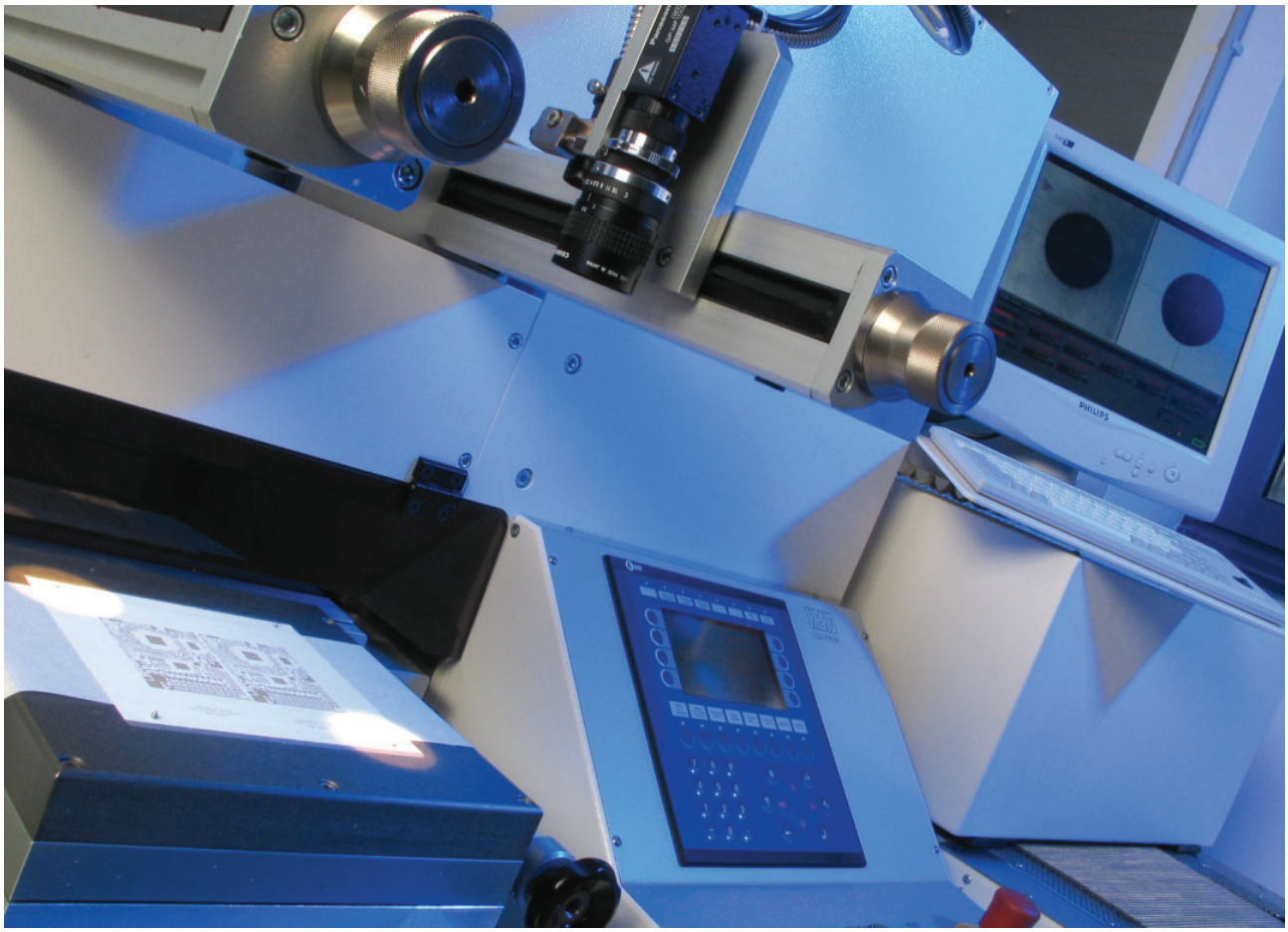
The technology of the machines for the manufacturing of most classic multi-layers components is very similar and therefore the development strategy of the company Keko Oprema is also to offer a wide spectrum of various machines. We follow the international trend, which aims to integrate the components. For the new elements, like LTCC, our activities are focused on the development of new machines and on the adaptation of the technology for their manufacturing.

Our completely developed production lines carry out the complete manufacture, including sintering of the ceramic mass for both components, classic and new. The production with prototypes and a production line for semi-products have been developed. In future, we are planning to develop a fully automatic line. Integrated LTTC components differ because they are meant for different applications. Therefore the way of manufacturing cannot be universal, but the machines should be adapted for the manufacturing of individual components, which require specific procedures.

The important advantage of the company Keko Equipment is the manufacture of machines that meet the customers' special requirements. We can already offer the equipment for manufacturing LTCC elements for both production types of those components (with or without ceramic foil on the supporting film). The offer is partly limited because we are not familiar with all the problems due to the punching of the foil. All the ways of punching (laser, mechanical punching) are being tested in order to offer a highly efficient punching machine, along with the existing one, on the market.

Furthermore, we are planning the automation of all the existing machines, including the automatic manipulation of ceramic foil on printers, cutting and punching machines, etc. in order to increase our productivity and to automate our production.

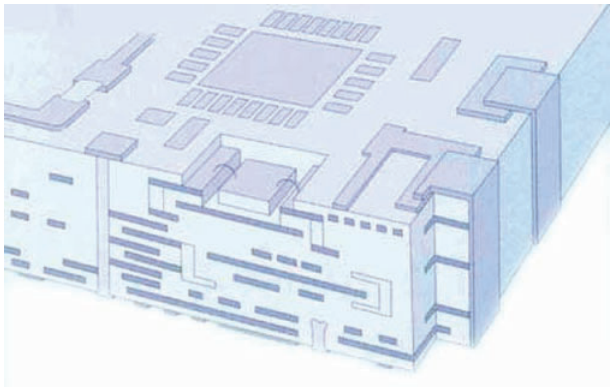
The future strategy of the company will be based on the complete manufacturing of the machines for mass production and specific manufacture of a wide spectrum of electronic components. We will make sure to maintain the international reputation, due to our knowledge, innovation and flexibility.



Technology News

The limits of the objective are defined
by the means that lead to it.
The starting point is a dot,
the goal is the entire world.

LTCC Production



The **L**ow **T**emperature **C**ofired **C**eramic (LTCC) technology can be defined as a way to produce multilayer circuits with the help of single tapes, which are to be used to apply conductive, dielectric and / or resistive pastes on. These single sheets have to be laminated together and fired in one step all. This saves time, money and reduces circuits dimensions.

Because of the low firing temperature of about 850°C, it is possible to use the low resistive materials silver and gold instead of molybdenum and tungsten (which have to be used in conjunction with the HTCCs).

Keko equipment can offer lab scale production lines as well as fully automatic lines for processing green tapes with or without carrier film.

A description of production steps:

1. Tape casting

LTCC producers usually use tapes shipped on a roll. For those customers who would like to develop LTCC tape or produce it by themselves, we offer a suitable tape caster such as CAM-1M model.

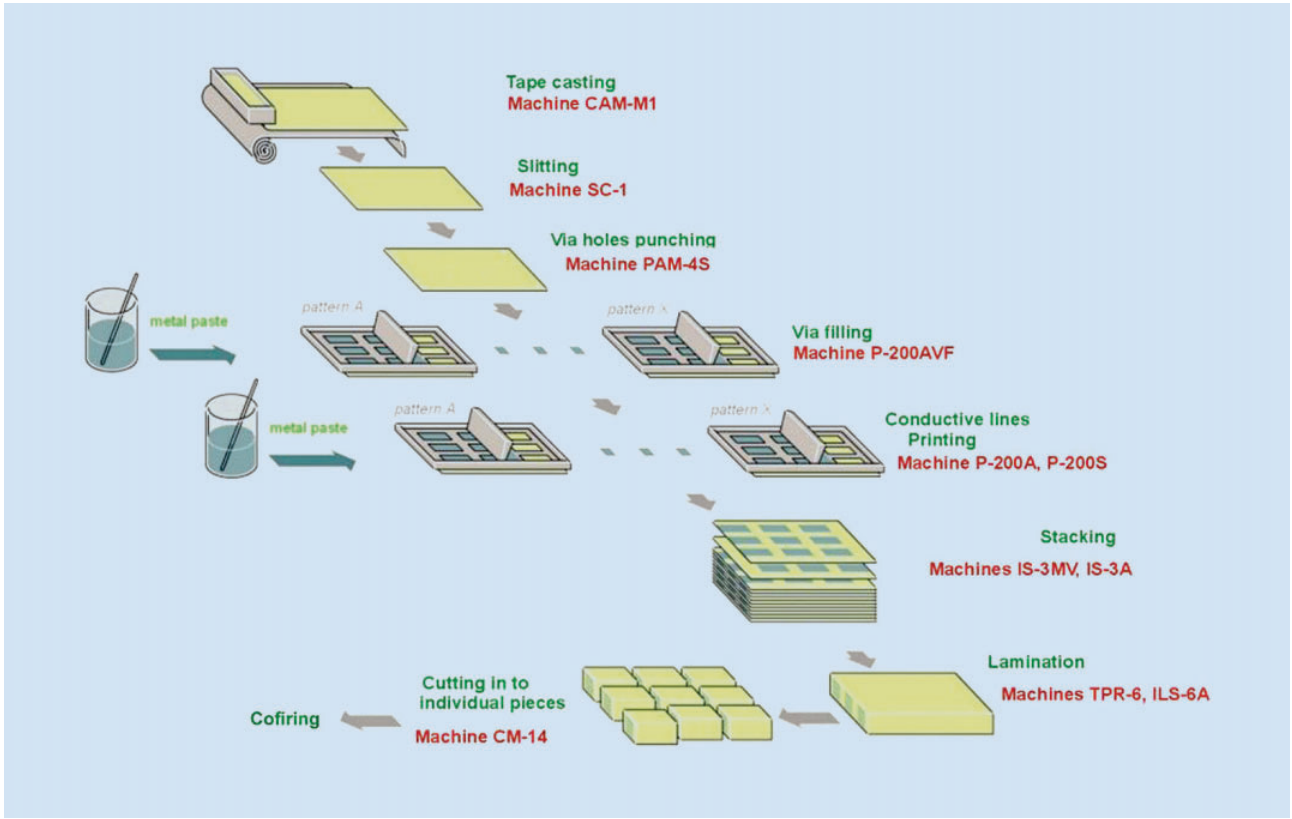
2. Slitting

A tape is unrolled and cut into individual pieces. For this purpose, our SC-1 sheet-cutting machine can be used. It can process either a ceramic tape cast on carrier PET film or tapes whiteout carrier film; it depends on the type. A sheet dimension is adjustable. It is preferred to rotate the single sheets in turns 90° to compensate the different x/y-shrinking of the LTCC.

3. Via holes punching

Vias may be punched or drilled with a laser. Most of available lasers have problem to punch white, thick, green ceramic tape, especially if the ceramic tape is on the carrier film.

For punching vias, Keko can offer single or multiple pin



high speed punching machines, with or without automatic tape handling. In case the tape is cut into individual sheets on the punching machine, a slitting machine is not necessary.

4. Via filling

Vias can be filled with a conventional thick film screen printer or an extrusion via filler. In the first case, the tape has to be placed on a sheet of paper that lies on a porous plate; a vacuum pump holds the tape on its place and it is used as an aid for via filling.

The second possibility to fill the vias is to use a special extrusion via filler that works with pressures of about 4 to 4.5 bar. Both methods need to have a mask; this mask should be made of a 150-200mm thick stainless steel. An alternative to that is to use the (Mylar-) foil, on which the tape is usually applied. For a via filling operation we can offer a P-200AVF printer with a via filling option, with or without an automatic sheet handling.

5. Conductive lines printing

Cofireable conductors etc are printed on the green sheet using a thick film screen printer. The screens are standard (250 – 400) emulsion or foil type thick film screens. Just like the via printing process, a porous plate is used to hold the tape in place. Printing of the conductor tends to be easier and of higher resolution than standard thick film on alumina. This is due to the flatness and solvent absorption of the tape. After printing, the vias and conductors have to be dried in an oven at 80 to 120°C for 5 to 30 minutes (depends on material); some pastes need to level at room temperature for a few minutes before drying.

With the help of our P-200A screen printer, it is possible to print conductors with a 50mm line resolution.

6. Stacking

Opposite to the process where each layer is placed in turns over tooling pins or where some processors use heat pliers to fix the sheets in turns one on top of the other, we stack one by one sheet by CCD vision alignment or by positioning pins. For this process, no special tools are needed. According to required productivity, we offer different possibilities. From manual IS-3M stacker, where registration pins do registration, (it is suitable for stacking only tapes on a carrier film) to IS-3MV machine where sheets are still placed manually but registration is done by computer vision, up to fully automatic IS-3A model. IS-3A model can handle up to 16 different tape patterns automatically, either from cassettes or trays. It depends on foil type (carrier film or not).

7. Lamination

There are two possibilities of laminating the tapes. The first one is uniaxial lamination; the tapes are pressed between heated plates at 70°C, 200 bar for 10 minutes (typical values). This method requires a 180° rotation after half the time. The uniaxial lamination could cause problems with cavities / windows. This method causes higher shrinking tolerances than the isostatic lamination. The main problem is the flowing of the tape; that results in high shrinkage tolerances (especially at the edge of the part) during the firing and varying thickness of single parts of each layer (it causes serious problems on the high frequencies sector). A suitable press would be our TPR-6.

The second way is to use an isostatic press. The stacked tapes are vacuum packaged in a foil and pressed in hot water (temperature and time are just the same like using the uniaxial press). The pressure is about 350 bar. We recommend our ILS-6 model.

8. Cutting into individual pieces

After laminating, the parts are usually cut into the individual pieces. For this purpose, our manual or automatic CM-14 model-cutting machine can be used. It cuts up to 5mm thick green ceramic bars on a vacuum table with a hot blade.

For those customers who would like to do half cut of the stack, a modified version of standard cutting machine is available.

If the fired parts have to be cut into smaller pieces or other shapes, there are three different possibilities. The first one is to use a post fire dicing saw, which holds tight outside dimensional tolerances and allows high quality edges.

9. Cofiring

Laminates are fired in one step on a smooth, flat setter tile. The firing should follow a specific firing profile, which causes the need of a programmable box kiln. A typical profile shows a (slow) rising temperature (about 2-5°C per minute) up to about 450°C with a dwell time of about one to two hours, where the organic burnout (binder) takes place; then the temperature has to be risen up to 850 to 875°C with a dwell time of about 10 to 15 minutes. The whole firing cycle lasts between three and eight hours (depends on the material; large / thick parts cause the need of a modification of the firing profile).

Tape casting machine CAM-M1A

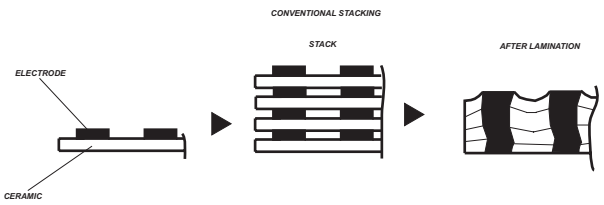
Our CAM-M1A casting machine represents a new step in a ceramic tape casting control. The design of the machine is based on our successful CAM-M1 model.

The machine automatically controls the casting process. All important parameters, such as blade gap, drying parameters, tape tensions, slurry level, casting speed, etc., can easily be entered via touch screen panel, or called any time from a computer memory. The operator's work is reduced to the connecting a slurry tube at the beginning of the casting process and to remove the roll of the tape in the end. The optional software allows a connection to the external PC where the casting process can be controlled and monitored. The machine can be equipped with laser thickness measurement in order to observe tape thickness deviation.

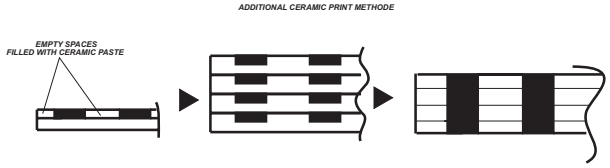
MLCC production:
High Layer Count Stacks

Nowadays a multi-layer ceramic capacitor production requires thinner dielectric layers (down to 2 micrometers) and over 500 layers count stacks. The problems of high layer stacking reflect in alignment and delimitation. We have developed procedures and machines to avoid or minimize high layer count stacking problems.

Printing-stacking machine PAL-9



Our method: fill empty spaces between electrodes with tape compatible ceramic paste to avoid this problem.



Solution 1: Using our **printing-stacking machine PAL-9** with two printer heads, one for printing electrodes and the second for filling the ceramic paste between electrodes, the problem can be solved.

MLCC production: High Layer Count Stacks (2)

Solution 2: Using our **roll to roll printer RTP-1**, where you get very uniform electrodes print and standard **PAL-9 printer stacker modified** for a tape positioning on the stacker.

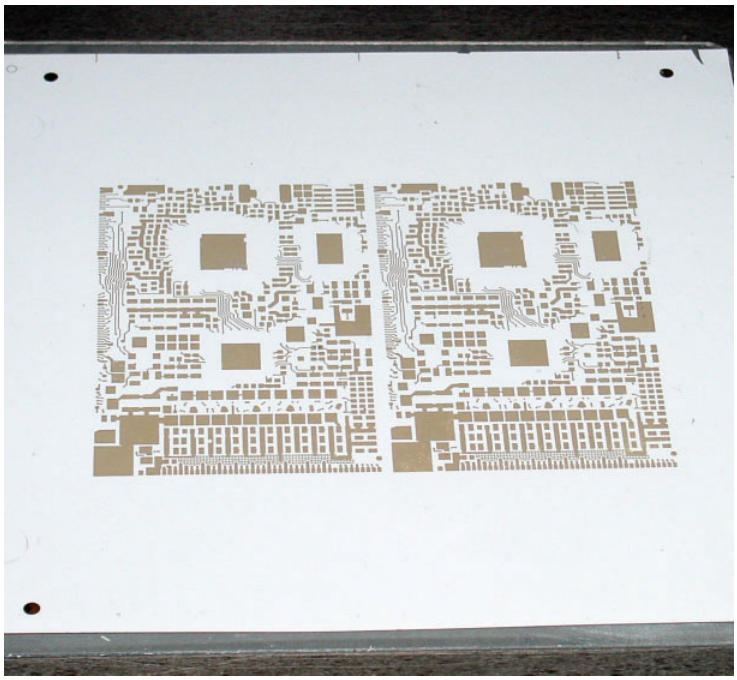
Development projects

1. Thin layers tape casting

At the implementation of the project we cooperate with the Institute Jožef Štefan, Ljubljana, Advanced Materials department. The department is responsible for the development of new materials that are needed at the project of the tape casting machine. The institute is one of the leading European institutes in the field of ceramic materials. In addition to a superb staff, they also use the most modern equipment to carry out analyses of raw materials and microstructures.

Due to the cooperation with the institute, we can use their expertise and equipment, which is of great help at the projects where we cooperate with our buyers. The development project is supported by the Ministry of the Economy of the Republic of Slovenia. A part of the project is also a continual laser measurement of the thickness of the foil.

SEM Jeol 4800 is used for micro-structured analysis of multi-layer components

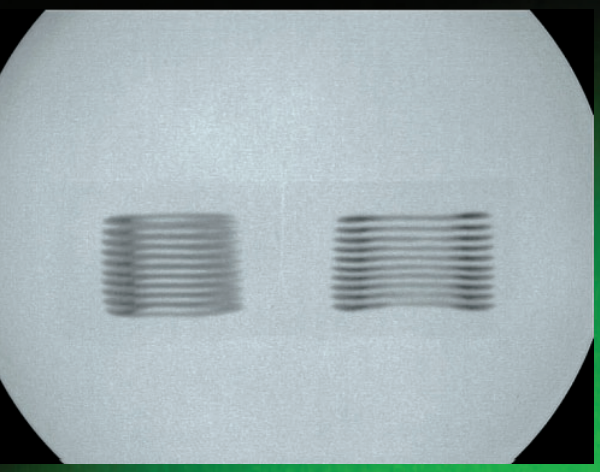


LTCC foil

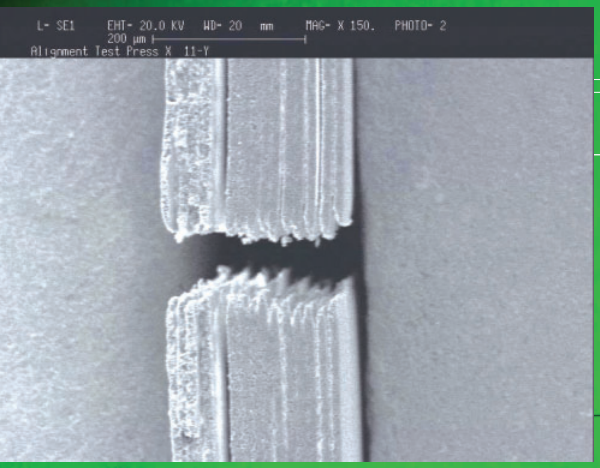
2. The development of a LTCC Stacking machine

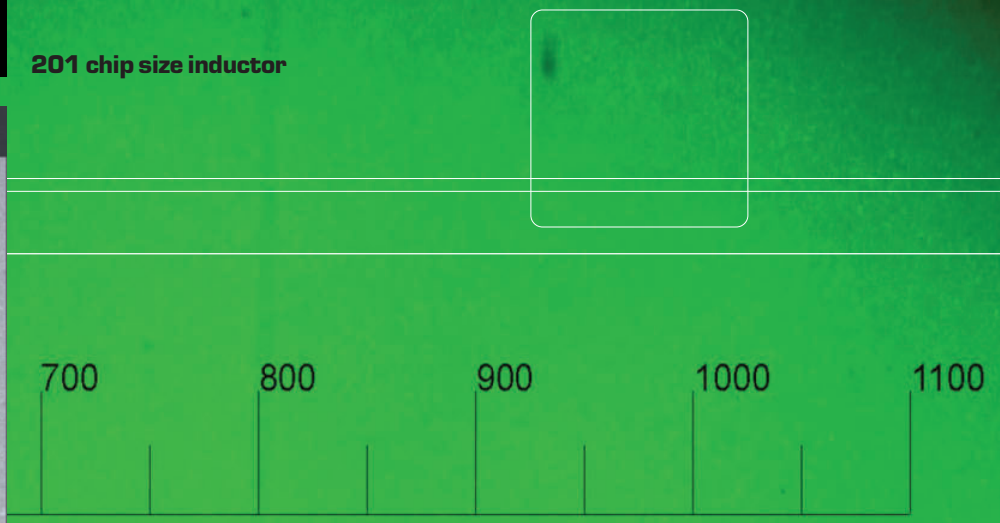
Within the framework of the above-mentioned project the new LTCC machine with the use of a Vision alignment is being developed. At the same time, we are investing in new machines that will enable us even lower tolerance of manufacturing the critical parts of the machine, which will contribute to a greater precision of stacking layers. The Ministry of the Economy has supported that project as well.

Development projects

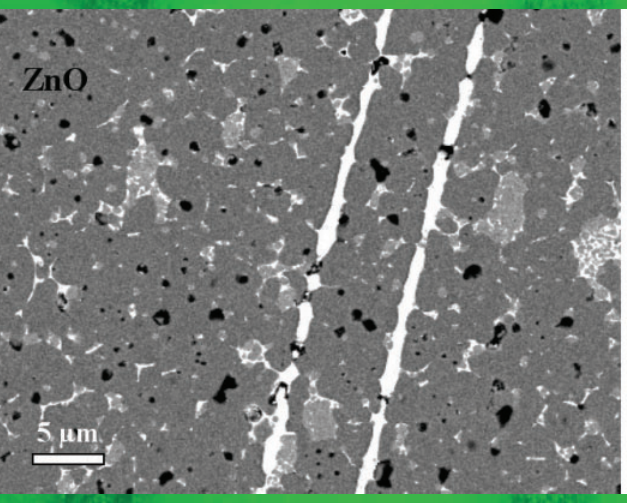


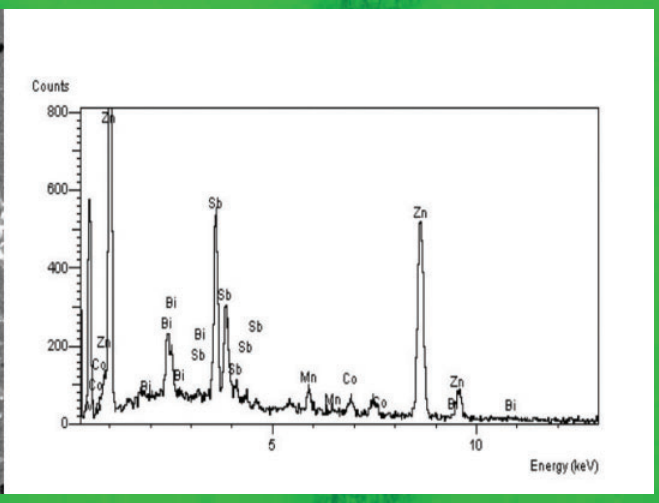
201 chip size inductor





40 microns VIA stacking test





SEM BSI picture of multi-layer structured VDR and EDXS spectrum (chemical analysis) of spinal part in microstructure

Picture in the background: fine line printing

The whole world as the crossroads of potentials and ambitions.

Market Situation

Market situation

The spectrum of the machines that we have been trading with recently has changed a little bit. The majority of manufacturers have already created enough capacities for manufacturing their basic products. Therefore we have been trading mostly with the machines and lines for manufacturing new components and we have been trying to improve the quality of manufacturing of the existing lines.

Tape casting machine CAM-M1 has proved a very good solution for casting very thin layers (within 5 microns) in a satisfactory casting tolerance. The efficient system of drying used for the casting of thick layers which can reach the thickness of 200 microns and more. Some of the novelties which are the most important advantages of the machine are: the new system for the automatic setting of the casting blade height, the control of the slurry level before the casting blade and last but not least, the attractive price.

Printing-stacking machine PAL-9 is still a machine that has the best relation between the productivity, precision in stacking and a price. Its flexibility enables the manufacture of a wide spectrum of products, including the total automation of LTCC production.

Cutting machine CM-14: With the improvement of the engineering, the use of the new blade designs together with the use of the new system for fixing a bar, we have achieved very good results in cutting the small dimension chips and in cutting the bars of 7 mm thickness as well.

Lines for the production of conductors, LTCC: We have sold some entire lines for LTCC production. The line includes the entire procedure, from casting a tape to cutting it into individual pieces, punching, VIA filing, printing of conductors and automatic or manual stacking with the help of gases or the vision system. The whole line can also be seen in our show room, where several tests can be performed as well.

PADS FP5 Project

In the European Union's funded Fifth Framework development programme, the Keko PAL-9 is used to produce prototype multilayer Piezo ceramic transducers. The multilayer transducers were transformed into their final shape after printing and stacking.

PADS FP5 Project

PADS (Piezoelectric Array Device Systems) consortium, winning one of the first grants awarded under the European Union's Fifth Framework programme. The award, made in April 2000, is for a 2.5 year project funded to the amount of 2.1 m Euro.

Example of 3D multilayer Helimorph® structures

The objective of the Framework programme is to stimulate and encourage the development of commercially viable new technologies within the EU, bringing together industry and academia into working collaborations.

The **PADS consortium** comprises:

- Haiku Tech, The Netherlands:
- 1 Limited, UK
- Marconi plc, UK
- Laboratoire des Ondes et Acoustiques (LOA), France
- University of Erlangen-Nuremberg, Germany
- University of Birmingham, UK
- University of Science and Technology (UMIST) in Manchester, UK

The target helix shaped actuator is a revolutionary development in the field of ceramic actuators. The patented design of the actuator produces a device that is compact, lightweight, capable of very large displacements (up to many millimetres) and capable of efficiencies unmatched by comparable electromagnetic motors or solenoids. Its motion is highly linear, and readily controllable through simple-to-implement electronics. The Haiku Tech task has been successful to develop multi-layered ceramic actuator technologies that can be produced in complex high layer count 3D-shapes.

Helimorph® devices are made from a tape of two or more layers of piezoelectric material, which are surrounded and separated by conductive electrodes to form a bimorph.

The behaviour of a bimorph under an applied voltage is like that of a bimetallic strip exposed to changes in temperature. When a voltage is applied across a bimorph one layer shrinks and the other expands. As the two layers are adhered to one another, this behaviour causes the bimorph to bend.

To form a Helimorph®, a bimorph tape is first wound into a primary helix.

If a primary Helix were to be activated, the incremental bending of each segment would result in a slight contraction or expansion of the helix diameter. In addition to this, one end of the device would rotate relative to the other.

Once the primary helix is formed into a secondary arc, the rotation causes one end of the Helimorph® device to displace linearly relative to the other.

Due to the high displacement of the actuators, a combination of benefits can be achieved like high displacement, low power use, fast frictionless silent operation.

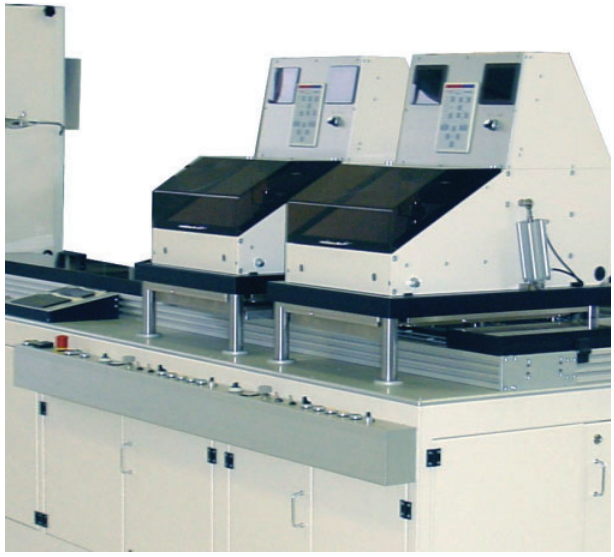
In the passive component industry the Keko PAL-9 printing and laminating machine is used world-wide for fully automatic production of multi-layer stacks at high productivity rates.

However in the passive component industry the 3-Dimensional shaping of green stacks is not very common.

Thanks to the development work made by Haiku Tech and its partners in the PADS project, the Keko PAL-9 now also can be used for producing 3-Dimensional multilayer ceramic structures, utilising green tape with high flexibility.

Starting with the planar print on stack technology, all the benefits of the Keko PAL-9 printer stacker can be used. The proven high efficiency and extreme accuracy of the machine assures accurate stacking of the multilayer, resulting in optimum efficiency of the Piezo stack. The use of relatively flexible green tape allows the stack to be bent into a helix or Helimorph® shaped structure. The final shape is fixed during the isostatic press cycle, resulting in stable helix shaped structures during binder burnout and firing.

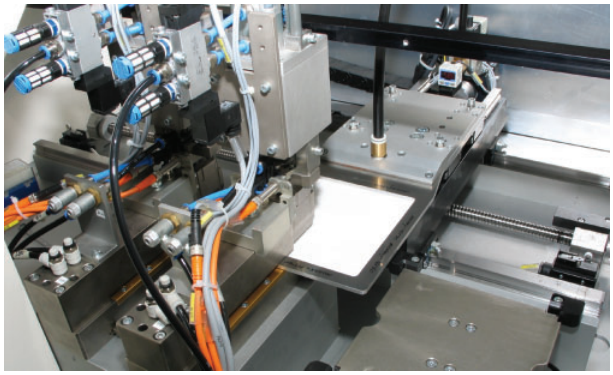
HELIMORPH® is a trademark of 1 Ltd.



Highlights

Punching machine PAM4/8S

To complete LTCC production line in year 2003, first single pin punching machine has been introduced to the market. Up to 8 different punching tools can be installed. Machine can handle tape from roll or individual sheets.



Automatic stacker IS-3A

A new version of automatic green sheet stacker with less than 7s cycle time specially developed for large LTCC and inductor production volume, can handle either tapes on carrier film (mylar) automatically from cassettes or green tapes without myar from trays. Up to 16 different patterns can be processed. Tapes can be aligned by computer vision or by registration pins.

Roll to roll printer

New designed roll to roll printer can be used in different applications where plastic or ceramic tape from a roll, has to be printed by screen-printing. Machine can punch also registration holes in order to register prints on further steps, such as stacking, etc. Computer vision control controls print quality.

The improved PAL-9 printer stacker

The improved PAL-9 printer stacker, with 7x7 inch printing area has 30% higher productivity comparing to a previous version. One of the worldwide biggest MLCC producers considers the improved PAL-9 stacker the most complete way for MLCC production.

Trade Fairs & Exhibitions in 2003

SMT 2003, Nürenberg, Germany

CARTS 2003, Scottsdale, USA

ACERS 2003, Nashville, USA

KEKO EQUIPMENT

Company Profile

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KEKO Equipment Ltd. is a leader in the manufacture of machines for the production of multilayer passive ceramic components.

Twenty-five years of experience have given us the vast knowledge that is now marketed under our own brand in the Asian, European and American markets.

Our roots stretch a long way back to when we were a unit of the Iskra consortium. Since 1995 the company is in private hands and its philosophy today is formulated by a team of highly motivated engineers and designers. In addition to the extensive range of proven products, we focus our specialized know-how into custom manufacturing.

In the development of specialized technological solutions we take into account our customers requirements and the needs of each individual buyer, thus providing the basis for a successful long-term relationship.

This is aided by our widespread sales network that spans three continents, where we always cooperate closely with knowledgeable local agents. They have helped us to provide very successful post-sales services and ensure customer satisfaction.

Knowledge, flexibility and innovation are our company's key competitive advantages and our brand name's good reputation now reaches all over the world.

Production: Studio Virc, Print: Tiskarna Novo mesto, November 2003