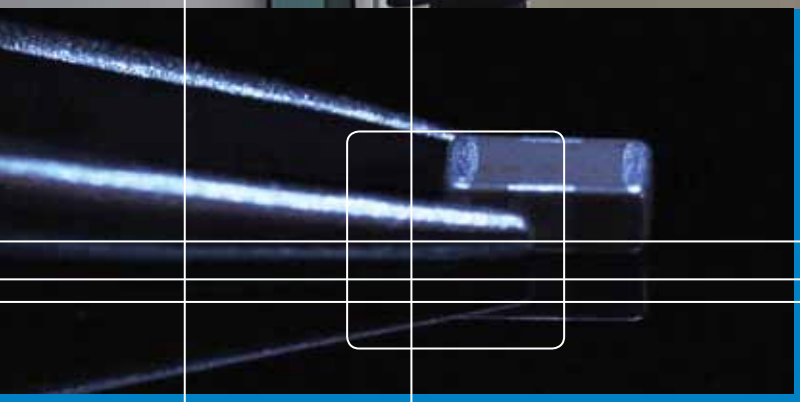


KEKO EQUIPMENT

Keko Equipment NEWSLETTER No. 7

“ Large Investments are good and positive sign”

We recently sat with Keko Equipment’s CEO Tone Konda and its Technical Director, Jože Štupar, to have a conversation about the company’s state of affairs and future plans.

You are currently making a large investment, which is always a good and positive sign. Can you please elaborate on what this new investment is and what it will mean to Keko Equipment and its customers?
JŠ: Yes, we are expanding our production capacity and eliminating bottlenecks. Machines with a large footprint have always presented a problem for us; we simply did not have enough space in our production floor. We are also buying new machines (for our machine shop) to increase our capacity to produce mechanical assemblies. With this new investment we will be increasing our physical capacity to 1800 m2, which in turn will increase our capacity to develop new machines, technologies and material support for multilayer components.
TK: This goes hand in hand with our policy of allowing customers to test out their materials in the equipment available in our demo room. We are now also planning to offer test materials to facilitate the startup process for our customers; this will definitely complement our current activities.
JŠ: We cannot look at machines as isolated products; we must take a comprehensive view. Knowledge with regards to technology, materials and compatibility is fundamental to be able to offer the best manufacturing solutions.

So you are not only investing in additional physical capacity, but on offering comprehensive market solutions?
TK: Of course! Our sales figures have been good in the past few years, and this is largely due to the fact that we offer a complete service. A complete package, including material support, is just as important as the machines. We are not just about equipment, as it might seem at first and as the company’s name might imply. Today we are actually attending our new associate’s defense of his doctoral dissertation; he will be responsible of our materials support service.
JŠ: Yes. We believe there is much to be gained from applying science to our field of activity. He will serve as the connection between us and the institute – that is, the “Namaste Centre of excellence” at the Jožef Štefan Institute in Ljubljana. Many times we have been faced with the issue of who’s at fault when some issues arise, is it the (customers) materials or the machine? In order to minimize these instances we will offer our own material support service in cooperation with the Ljubljana Institute. There is still a major gap between science and industry practically everywhere in the world. Though we are fundamentally engineers, we are rapidly expanding our activities into the fields of chemistry and physics.

What does this mean for your customers?
TK: Most customers already buy comprehensive solutions and complete lines.
JŠ: We are certainly strong when it comes to providing a complete service, including support with regards to materials.
TK: We wish to have a complete in-house package. There are almost no suitable providers, and in many case things do not work out the way customers expect, so there is no reason for us not to expand our operations to include material support.

How would you describe the recent market conditions?
TK: We have noticed that the situation in the US and EU markets is at least partially improving. A lot of grants are being given for defense and other strategic industries. This is not always in line with market logic, but it is a fact. The Germans are doing well because they are successful in the Asian markets. China still constitutes our main market, and the Russian market is coming along very nicely. Russia is (very) successfully establishing a technologically strong industry, and we are part of it.
JŠ: In recent years, we have covered different branches

of industry, though many of our endeavors were (sadly) only transient in nature. A typical example was solar cells and related grants; but our main market remains in the industry of passive electronic components, such as multilayer ceramic products. We remain here, we perform well – we see that this market is functioning properly.

How would you assess your future prospects?

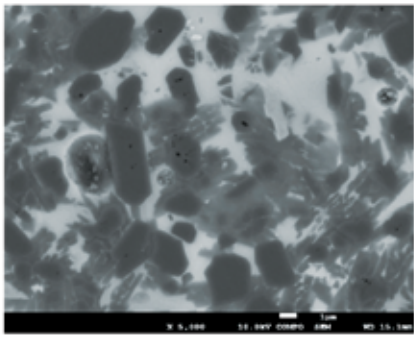
JŠ: We have made some innovations; and have designed and produced a diverse line of machines to cover a wide range of applications. There are more and more customers that need to produce complex products, this is an area where we are extremely competitive with our customized units.

TK: We are not targeting the largest companies; most of our machines are not designed for production on such a large scale, we are mostly interested in medium and small size customers. Many (new) customers do not possess the required technical knowledge to produce what they want, and we can help with our many years of experience and fully support them. We invite them to our facility for training and testing, and devote time to each and every one of them.

JŠ: Each customer is different, it could almost be said that there is no "typical customer". We must adapt to the local regulations in America, Germany and China. For example, lead is still used in some places.

TK: It is interesting that there are almost no new players (competitors), at least not in Europe, but that doesn't mean that we will rest in our laurels; we will always continue to find innovative ways to offer the best manufacturing solutions for our customers, and will do our upmost to provide complete solutions. This makes it easier for our customers to develop new products, especially for small companies with limited capabilities. It could be said that we are actually solving their technological problems rather than ours.

History of LTCC



Low Temperature Co-fired Ceramic (LTCC) is nowadays being increasingly used to fabricate substrates for the production of multilayer ceramic circuits, mainly for telecommunications, automotive, and medical applications. A variety of different LTCC materials with different properties are commercially available. Depending on the main target applications, the compositions of LTCCs as well as their properties, mainly the dielectric constant and dielectric losses, are different. The LTCC was developed on the basis of the multilayer ceramic technology developed in the late 1950s based on improvements in electronics production in the RCA Corporation, New York, United States, and with the support of the basic processes for the production (tape-casting method) and processing technologies (multilayer laminating processes, "via-forming" technology), which were developed at the same time. The main reason for the progress of multilayer production technologies was the rapidly growing production of computers in the company IBM. They developed the first ceramic multilayer circuit board with a size of 9 cm^2, with 33 layers and with 100 flip chip bonded large-scale integration (LSI) components. The multilayer circuits were realized on alumina-based substrates with conductor materials of Mo, W and alloys of Mo-Mn with a high specific resistance (around 10 μΩ·cm). The structures were fired at 1600 °C in an inert atmosphere to avoid the oxidation of the metals. Such circuits were a building block of IBM's mainframe computers in the early 1980s. Such circuits based on the described technology are called high-temperature cofired ceramics (HTCCs).

Later trends in the electronics industry to reduce the dimensions and increase the speed of mainframe computers in the middle of the 1980s led to the development of multilayer electronic circuits with a greater wiring density, i.e., with a larger number of thinner conductive lines. To overcome the problem of the higher resistivity of fine (thin) conductive lines the metals with a lower electric specific resistance, such as Cu, Ag and Au, were suggested.

However, due to the low melting point of these conductive materials, ceramics substrates, that sinter below the melting point of the metals (below 1100 °C) were needed. The metals with melting points below 1100 °C that have a low specific resistance are silver, gold and copper and theirs alloys.

Besides the low sintering temperatures, materials for substrates with low permittivity, low dielectric losses, as well as good mechanical and thermal properties were needed in order to further reduce the size and increase the speed of the electronic circuits. In addition, as mentioned before, the use of conductive materials with a lower resistivity printed on such substrates makes it possible to decrease the width of the conductive lines for the same electrical properties, compared to wider conductive lines with a higher resistivity. The interconnections (joints) between the surface-mount devices such as capacitors, resistors and mainly silicon based chips, which are soldered to the narrower lines, are mechanically weaker compared to the interconnections with thicker conductive lines. In order to ensure a reliable interconnection with narrower conductive lines, the thermal expansion coefficient (TEC) of the substrate must be close to the TEC of silicon-based chips as well.

The materials with the desired electrical properties, which were sintered at temperatures around 850 °C, were developed in the late 1980s and were firstly used with copper conductive lines and therefore fired in a reducing atmosphere. Further developments of the material introduced silver- and palladium-based conductive lines, which enables firing in air. Such materials are named low temperature co-fired ceramic (LTCC). The nowadays mostly used LTCCs belong to the group of glass/ceramic composites which are suitable for the production of multi-layer electronic circuit substrates.

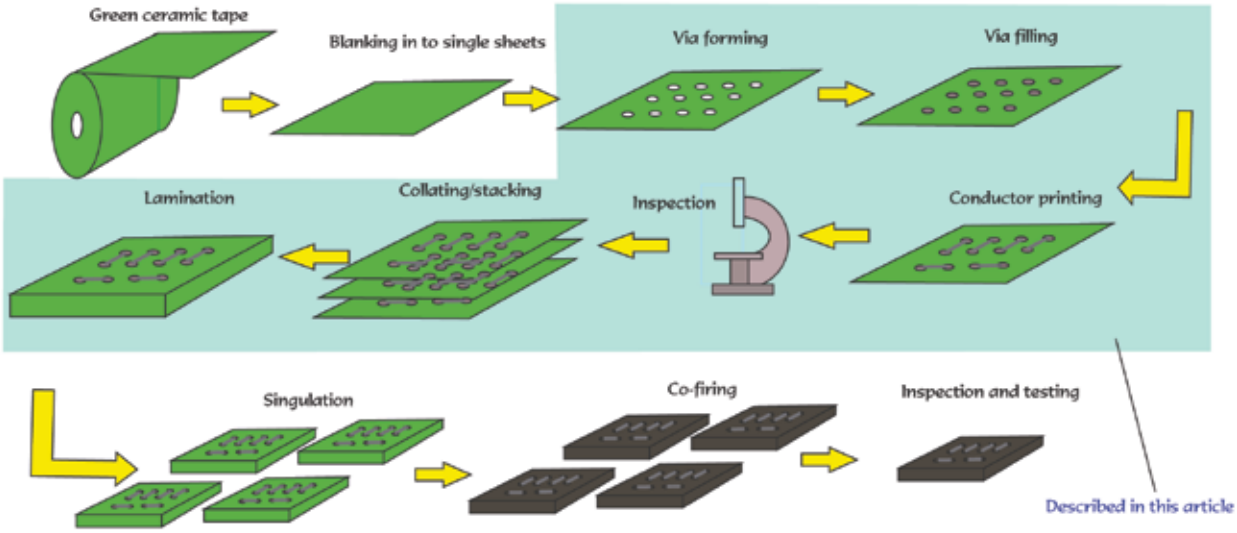
Dr. Kostja Makarovič, Keko Equipment

LTCC Production

Principles, challenges and practical advices from via forming until lamination

In this article I would like to discuss some typical production problems that most LTCC producers experience between the via forming and lamination steps. For the purpose of this article I'm assuming that standard/ commercially available LTCC tapes will be used. If you plan to formulate and produce your own (proprietary) LTCC ceramic tape please feel free to contact Keko Equipment to discuss about our different tape casting solutions and the potential issues with this approach.

LTCC production steps



1. Via forming

Today, the common via diameters range from 30 to 300 microns. Vias can be formed by mechanical punching or by laser drilling.

Mechanical punching

Recommended machine: Keko's PAM series mechanical punching machines.

Mechanical punching is done using carbide punching tools (pin/die).

Minimum punching diameter is 80 microns (production scale) and 50 microns (lab scale).

Punching speed using a single pin is up to 20 holes/ sec.

Punching speed using multiple pins is up to > 100 holes/sec.

Advantages of mechanical punching:

- Punching through PET carrier film (Mylar).
- Clean, well defined cut without changes in the properties of the material.
- High productivity using multiple (gang) punching tools.
- (Relatively) low cost investment for base machine with two punching diameters (laboratory scale machine).
- High dimensional accuracy.
- Wide tape thickness range (up to 2 mm).

Disadvantages:

- Minimum punching diameter is limited as pins smaller than 100 microns are very fragile. For small diameter tools we recommend using a servo motor driven punch (instead of a pneumatic tool) because it creates less mechanical stress on the punching pin.
- Tools wear out. The average punching pin lifetime is 2 million holes, for the die is 4 million holes.
- Time for tool exchange (10 minutes for pin, 30 minutes for pin and die).
- Less flexible compared to a laser punch.

Problems: Tool wear highly affects the punching quality. Tool wear depends mainly on the thickness of the PET (Mylar) and the type. For thin PET (Mylar) foils (below 30 microns) it's difficult to punch after some tool wear is present; this is because the Mylar penetrates in between the pin and the die, and instead of being cut (punched) it's pulled out, which causes the tool to break. Thick PET (Mylar) foils (>75 microns) are difficult to punch using pins with small diameters (< 150 microns), they break easily.

Suggestions to improve the punching quality:

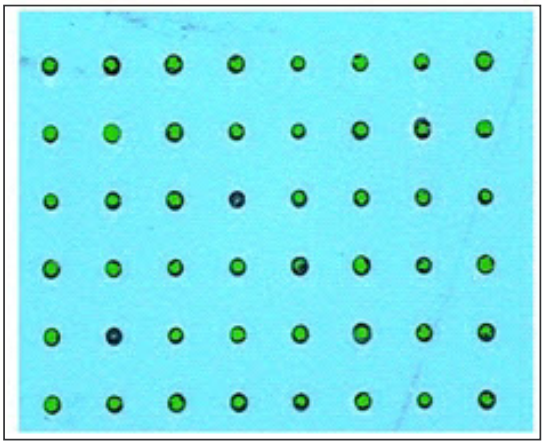
For best punching performance we recommend using "White" Mylar as the ceramic tape carrier.

This kind of PET film has been especially developed for mechanical or laser punching by
Mitsubishi. The thickness of this material is typically 50 microns.
We recommend having the PET film on top during punching, our experience shows that the quality of the punched holes is better and the tool lifetime is longer.
Thick ceramic tapes (above 200 microns) can be punched as well, but we suggest that they are punched without the PET carrier film. Punching without the PET film provides the longest lifetime for the punching tools; however, it is necessary to verify the behavior of the carrierless tape throughout the complete production process as unexpected shrinkage or distortions may occur.

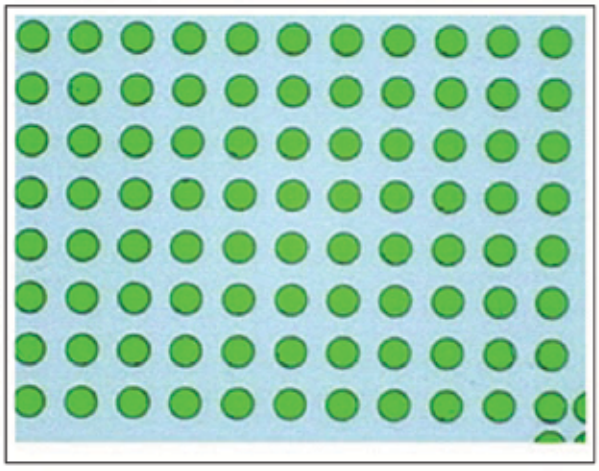
Laser punching: Please feel free to contact us for a complete laser punching solution, however, before a proposal can be issued we need to run tests with your ceramic tape to determine its compatibility with laser punching. Laser punching is mainly used in mass production of LTCC. Punching (laser drilling) is done
either by single beam or multiple beams (MLI production) through a laser beam mask. Common laser types, like solid state laser or C02 laser, are used.
Drilling speed: up to 100 holes/sec. using single beam mode, and up to several 1000 holes/sec. using multi beam mode.
Minimum drilling diameters: 10 micron (solid state), 100 microns (C02).

Advantages: High speed, easy programing, flexibility, smallest via diameters possible, low production costs.
Disadvantages: Not all tapes can be processed, difficult to keep stable drilling quality, LTCC tape shrinkage due to thermal shocks on Mylar and ceramic, glass forming on the vias' edge, is almost impossible to drill through transparent Mylar which creates difficulties to fill vias later on (for tapes >100 microns thick), melting Mylar and ceramic sometimes makes Mylar's releasing difficult.
Production problems: Different LTCC tapes produce different results; from very good to very bad. Short wavelength lasers (like UV) allow the forming of very small holes, but they also give problems because of glass forming on the edges of the holes, etc. Laser stability is also very important, even a small laser parameter change will produce completely different results.
Recommendation: We strongly recommend testing all production steps before deciding on laser drilling. Keko is currently not offering a laser drilling machine, although we tested many different laser sources, tapes, etc. The best performance we obtained was using a CO^2 laser; penetration of long wavelength laser is good in ceramic tape containing organic binders. We recommend caution when evaluating whether to use laser or not; the decision should come after the drilling quality for a particular material is verified, the properties of the material are under control and after the complete production steps are fully defined.

Laser drilled holes (30 microns dia.)



Mechanically punched holes (100 microns dia.)



2. Via filling

Via filling is one of the most critical steps in LTCC production. Different LTCC producers are using different methods for via filling. Most of them are using standard screen printing machines adapted for via filling. Some equipment suppliers are offering some "innovative" solutions, but almost none of them are used in mass scale LTCC production, thus I won't focus on them. The purpose of this article is not to explain the different via filling methods, but to discuss some common processing issues and the typical solutions using relatively simple approaches.

Suitable machine: Keko P200AVF

Via filling, regardless which method is used, has some limitations.

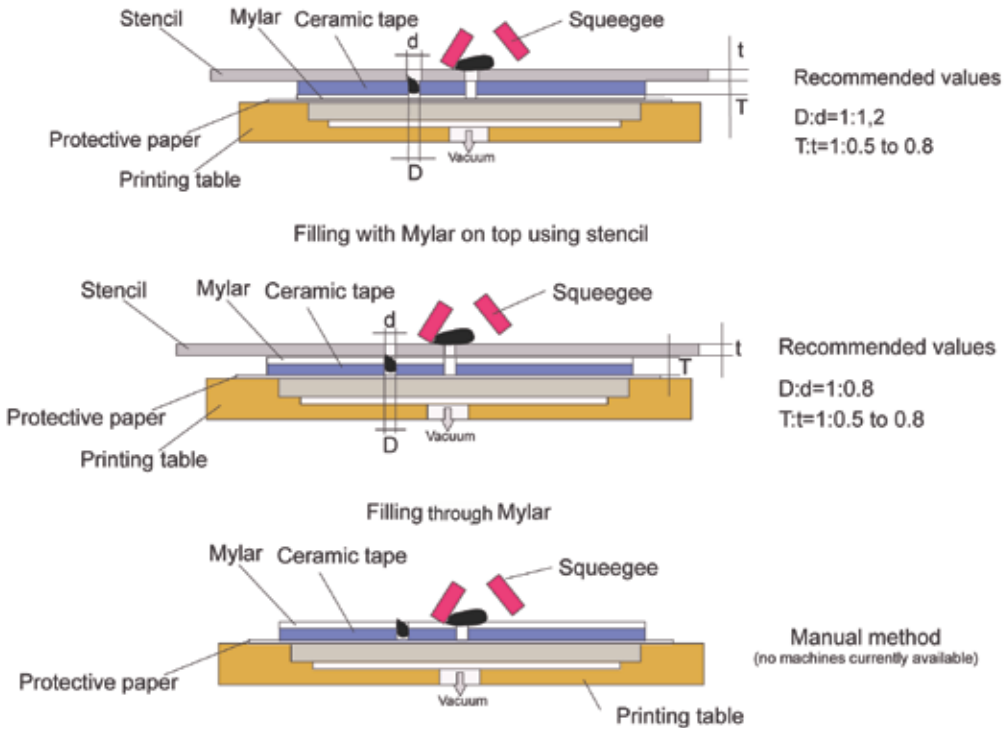
- It is very difficult to fill small size vias in thick tape. If the tape thickness / via diameter ratio is > 1 and via paste viscosity is high then the problems start.
- If the via diameters are larger than 0.5 mm there's a high possibility that the paste will leak out before drying (at any tape thickness), unless the paste has been especially designed for this application.
- If the tape is thin (< 30 microns) and the ratio between the tape and the hole diameter is smaller than 0.2 the via filling paste won't stay inside the hole.
- Small holes in a thick stencil get clogged with paste easily, consequently, via filling is not done properly. We strongly recommend using a thin stencil, doing several squeegee strokes instead of one (this will get enough paste through the stencil), running a continuous operation (intermittent operation causes blockage of the stencil holes). Holes in a thinner stencil are easier to clean than on a thick stencil.
- The method of using Mylar and holes in the Mylar as a stencil can avoid all problems related to using a stencil for via filling; however, it creates other issues, e.g. large paste consumption, difficult process and paste dosage control, etc.

Generally, it is necessary to adapt the via filling method and paste viscosity to make it compatible to the tape thickness and diameters of the vias. Suction (below the vias) sometimes helps and improves via filling on thick tapes with small via diameters, if suction is well controlled. Typically vacuum assistance is not needed for via filling.

Typical via filling parameters using a screen printer, stencil and double squeegee:

- Stencil / tape snap off should be 0 to 0.5 mm
- Squeegee speed 10 to 50 mm/sec.
- Squeegee pressure higher than for normal screen printing (depending on paste viscosity)
- Squeegee angle 45 to 60 deg. Normal rubber (75° Shore green) squeegee will do the job better than a metal squeegee. Use hard rubber or metal squeegees for very high viscosity pastes only.

Filling ceramic tapes with Mylar on bottom or tapes without Mylar with stencilil



3. Conductor printing

Keko Equipment production

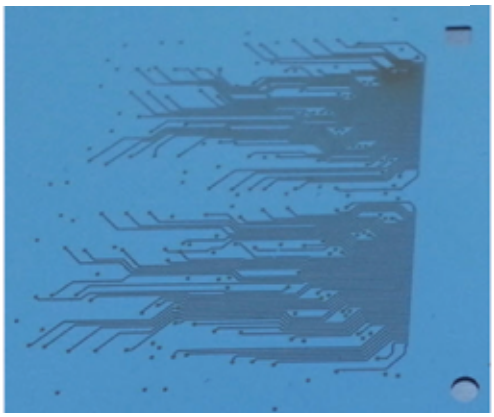
Screen printers testing before shipment

The printing quality (using a screen printer) mainly depends on the following items:

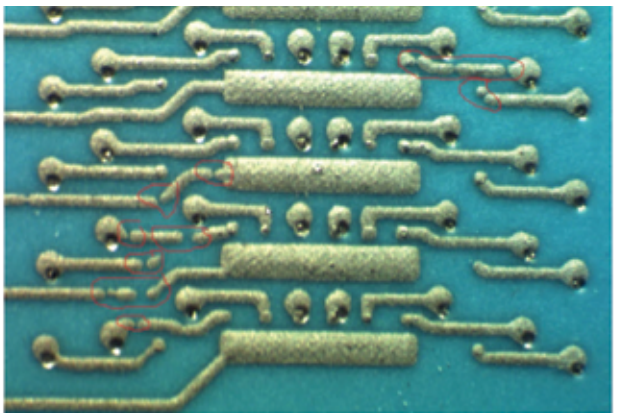
- Screen quality.
- Paste quality.
- Machine accuracy, repeatability and adjustments possibility. It is impossible to get good print quality if any of the above mentioned items is not ok. Currently, if using the best printing screens and printing pastes, screen printing technology allows printing 50 microns wide conductors and spaces; however, this is usually done under laboratory conditions for making prototypes; under real production conditions 100 micron conductor width is typically the minimum width possible.

Typical Production problems:
Fine line printing requires fine mesh screens. Today it is possible to use (in production) up to 600 mesh count screens (with extreme care), but 400 and 325 mesh screens are more commonly used.
Very fine mesh screens loose the mesh tension easily due to the (squeegee) forces exerted on the (very thin) wires. When using a very fine mesh then the squeegee pressure control and a uniform (force) distribution are very important. Spaces between the wires are very small, and unless all printing conditions are ideal the paste can easily block these small openings, causing areas of bad prints.

Example of fine line printing

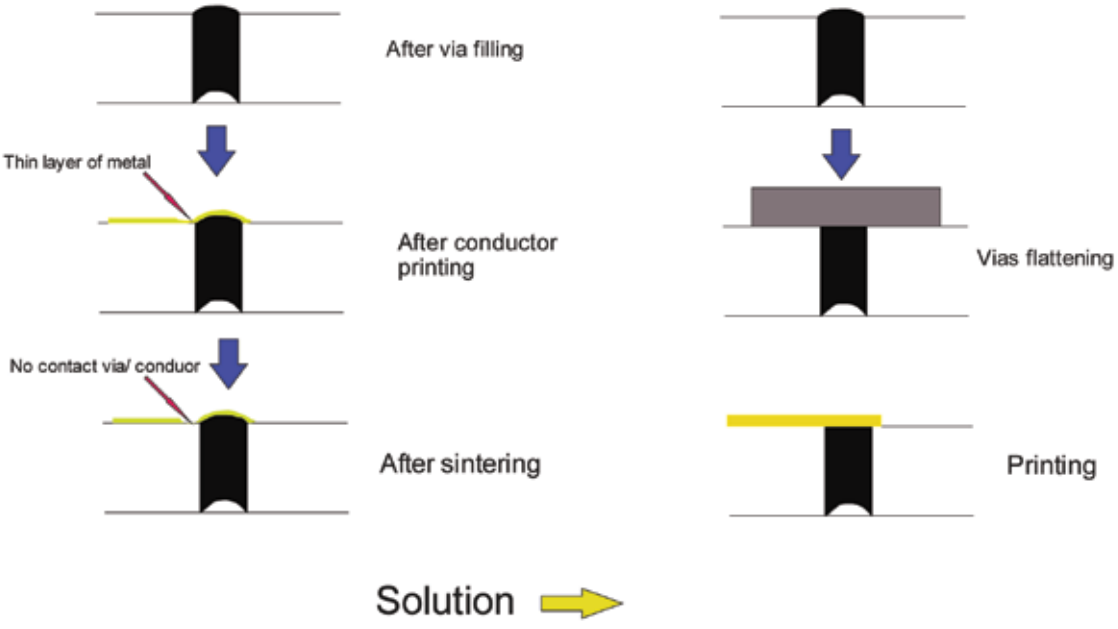


Example of printing mistakes shown after firing



Paste deposition through fine line mesh is low (low laydown). During the firing process the silver (metal) partly migrates, creating areas with no contact where the print is too thin. Sometimes is necessary to print several times in order to get adequate print thickness and consequently good contacts after sintering.
There's no consensus today as to which process step should be done first, via filling or conductor printing. Most LTCC producers are doing via filling first, but there are some who do the opposite. It's important to do some testing and take this into account because sometimes the (incorrect) order of these 2 steps may produce some issues, as shown on the following picture:

After via filling, surface is not flat, this disturbs printing process.



Once again, for best screen printing results the properties of the printing materials are more critical than the screen printing machine itself. On the printer itself it is important how easy the printing process can be set, as well as its repeatability and mechanical stability. On the other hand, the printing materials (pastes, screens, squeegee) have a direct influence on the print quality due to drying properties, elongations, etc.
Please read also my previous article regarding these topics in the Keko newsletter No.5.
http://www.keko-equipment.com/media/KEKO_Newsletter_2009.pdf

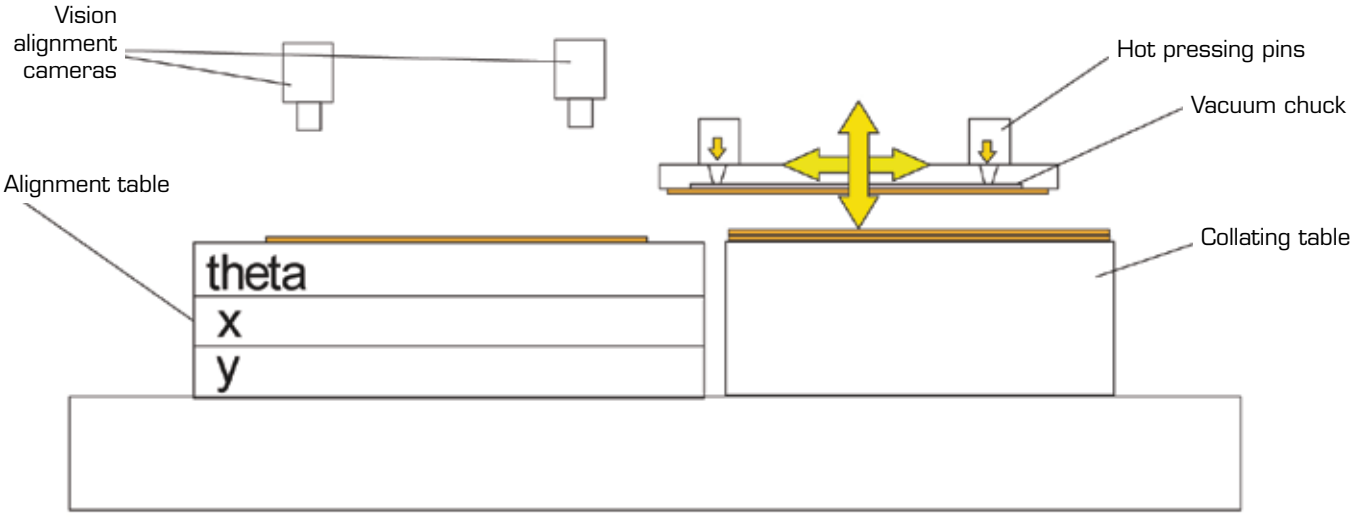
4.Collating / stacking

There are several collating approaches depending on the complete process technology.

Processing tapes without carrier through complete process

- If the PET (Mylar) carrier film is removed at the very beginning of the process (before punching vias), then the collator or stacker should be adapted for processing tapes without carrier film. Such process is suitable only for very thick ceramic tapes (>150 microns) which can be manually handled.

Typically, such collators are collating tapes using pressing pins. Every individual ceramic layer is pressed by several (usually hot) pins on top of previous one.



Advantage of this process:

- Relatively simple collating machine
- No pressing stress during stacking on the tapes (ideal for products with large cavities)

Disadvantages:

- It is highly possible that the ceramic tape shrinks during all previous process steps, especially during printing and drying of vias, which causes misalignment in the collator.
- When collating high layer counts, the stack is always pressed on same points, causing local deformations of the stack and tape shifting against first layers.

Peeling off carrier film just before collating

The same machine described above can be used, but the alignment table needs to have strong enough vacuum in order to hold the tape during carrier film removal.

Advantages:

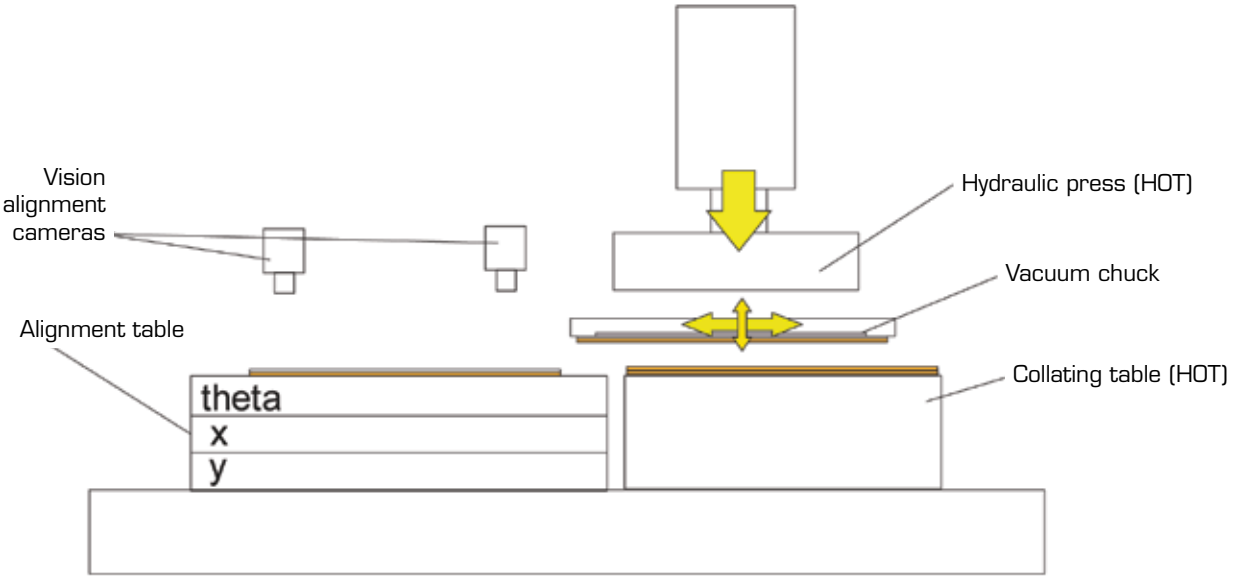
- Less possibility for tape shrinkage during previous processes.

Disadvantages:

- Same as previous process
- Suitable only for products which can be built from top to bottom. (Sheet can be placed with Mylar on top only onto alignment table).
- Automatic Mylar removal is difficult.

Collating/stacking first then carrier film removing

Basic machine principle is similar to previous, but in this method the complete surface of the LTCC sheet is pressed. After pressing carrier film is removed.



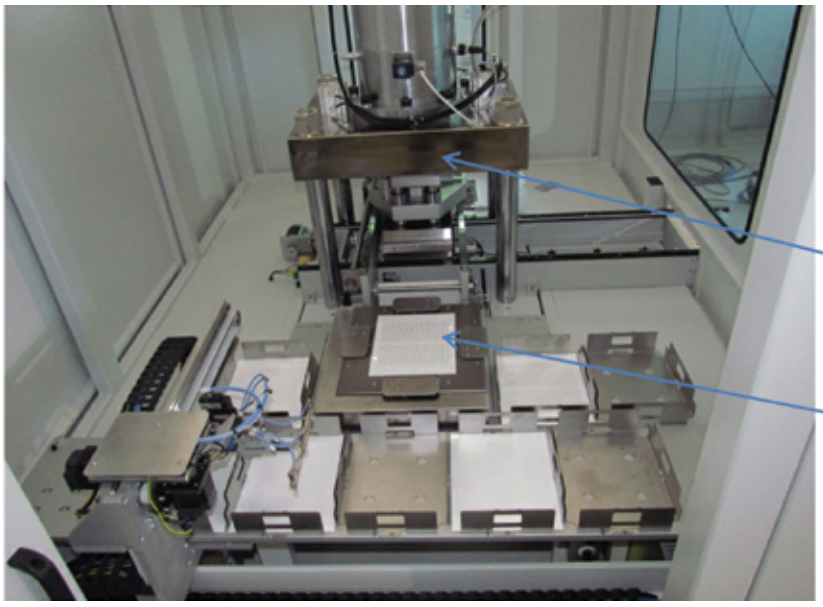
Advantages:

- Even less possibility of tape shrinkage, as ceramic stays on carrier film until it's tacked on top of the previous layer.
- More compact stack, higherlayercount stacks are possible.
- Better alignment accuracy as sheets are pressed on the complete surface.
- Full Automation can be offered.
- Possibility of stacking (pressing) inside a vacuum cavity.

Disadvantages:

- Higher investment costs due to a more sophisticated machine design, higher tacking forces and programmable pressure control.
- Not very suitable for components with big cavities, as relatively high forces are used and some distortions on cavities may occur if the tape does not tack easily and high tacking forces are applied.

Our most versatile stacker (collator) for stacking LTCC products is the SW type stacker, which can be offered for manual or fully automatic operation. Different versions can operate in any of the above described modes. It is recommended to perform stacking tests for each particular application before choosing a stacking method. We typically recommend pressing the complete sheet and then peeling off the Mylar, you can expect minimum stacking problems with this method.

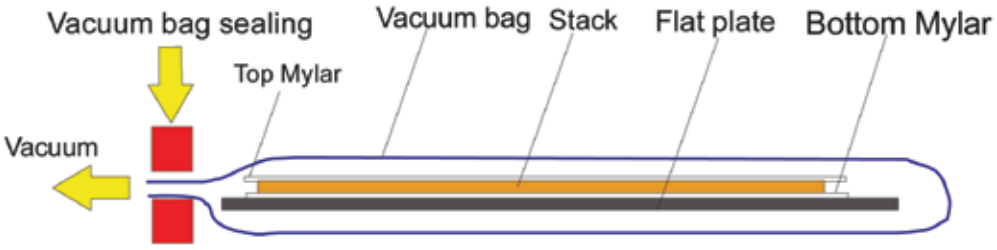


Automatic SW type stacker
Picks foils from cassettes, align sheets using vision fiducials, stack sheets with up to 42 tons force, peels off Mylar.

Good or bad collating (stacking) results are not only a reflection of the collator's performance; it's the result of the quality of each step, i.e. via forming, printing, drying and stacking. No machine can repair mistakes made in previous steps. I suggest that you read my previous article about other issues that can influence the alignment of the stack.

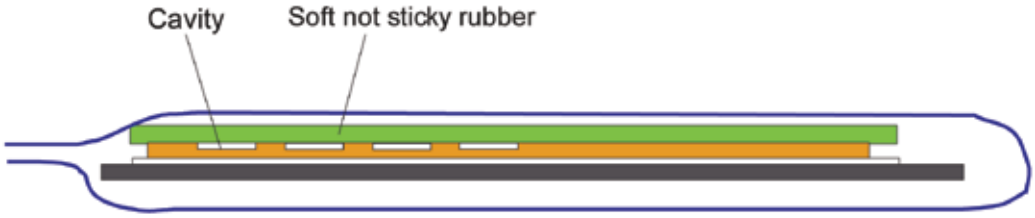
5. Lamination

Nowadays, mostly isostatic laminators are used for lamination. Some companies are also using uniaxial vacuum presses for lamination, but this lamination method is mainly suitable for small size products, with relatively low metal density inside and products that are not sensitive to nonuniform density (bending after sintering).

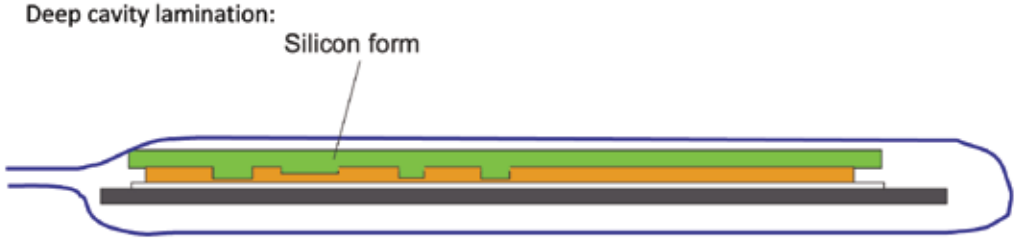


Isostatic pressing is not a complicated process, as long as you have good sealing bags, which can withstand high pressures and adapt well to the stack. For standard LTCC tapes lamination pressures of up to 42 MPa and temperatures of up to 80° C are sufficient. Thick products are more problematic to laminate because the bags could break (easier). Isostatic lamination could be challenging for products with cavities (internal or external), but here are some ways to laminate these products without damaging the cavity's geometry:

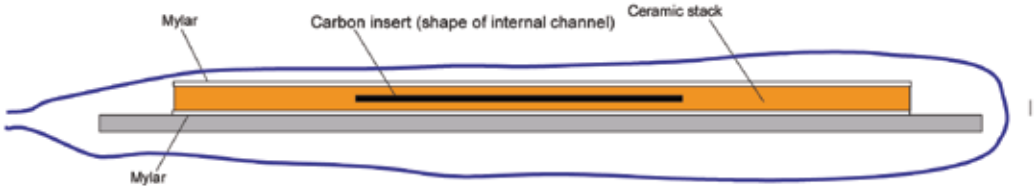
Low to medium deeps cavity lamination:



- Deep cavity lamination:



- Internal channels lamination:



A carbon insert is placed during stacking inside the channel. The carbon insert will burn-off during sintering

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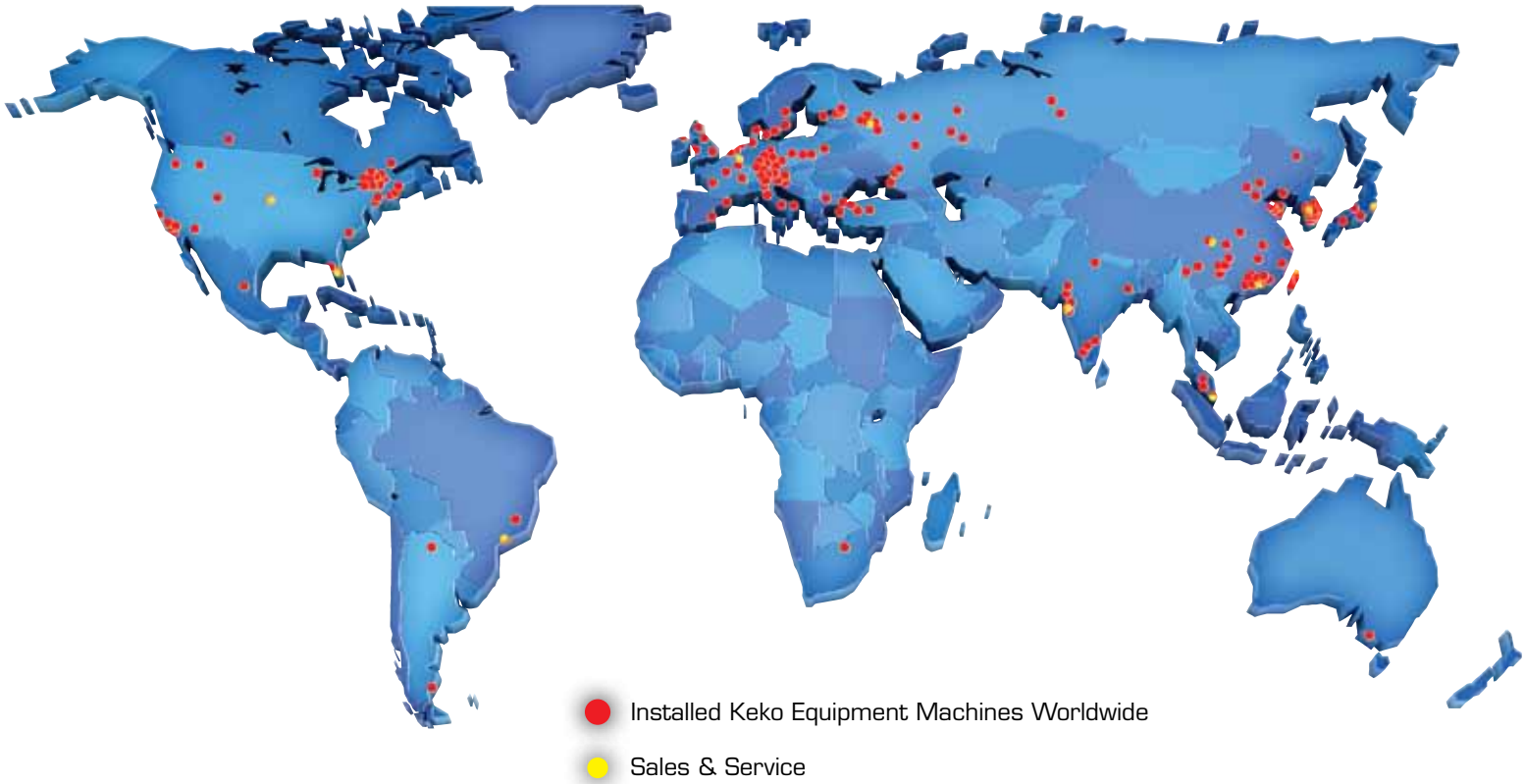
6. Conclusion

It is impossible to describe all technological challenges and the solutions or "tricks" in LTCC production in this short article; I've just discussed the most common ones. Production of LTCC requires knowledge about materials and production technology, suitable machines (and their proper combination); and it also requires adaptation and verification. Unfortunately, the final result is only known at the end, after the products come out of the firing furnace; at that point it is either good or bad and they can't be repaired afterwards, for that reason, to have success in LTCC production all the steps must be fully controlled.

Joze Stupar Technical manager Keko Equipment, Ltd.

Global Presence



Newly developed

Vacuum press

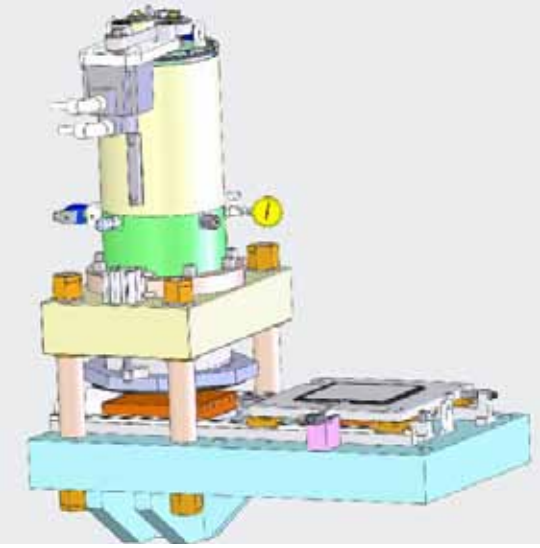
Vacuum press significantly improves stacking abilities of difficult taking foils.

Newly developed electro hydraulic cylinder enables up to 45 tons fully programmable pressing force, precise press stroke programming and noiseless operation.

Pressing is done in a vacuum chamber in order to remove trapped air between stacked layers during pressing.

All pressing parameters are fully programmable.

Vacuum press can be standalone machine, or integrated in most Keko stacker



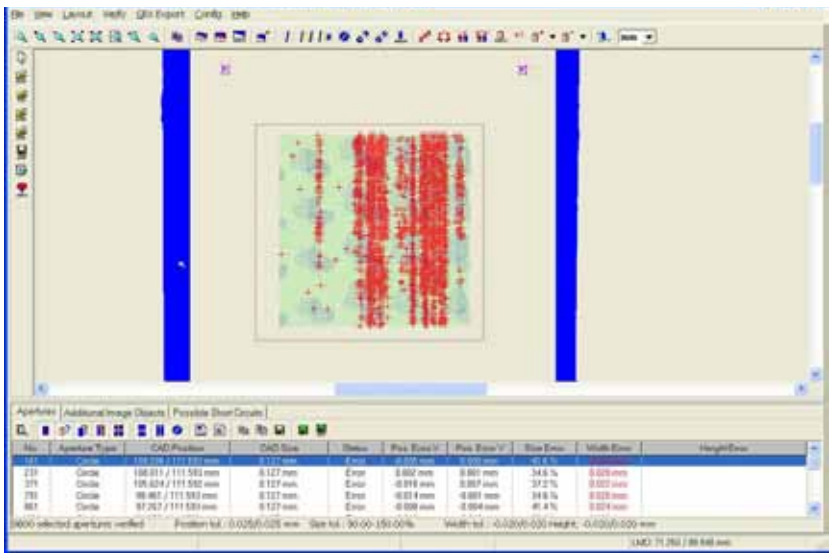
Punched holes vision inspection

Clear via holes in LTCC or MLCI tapes are important in order to have good contacts trough layers. Especially punching thick tapes and small via diameters, holes get easy blocked by cuttings. Tool wear significantly influences to clear cut and clear vias, from that reason via holes inspection before via filling is essential in order to have good contact between individual layers and consequently good product yield. Keko developed inline high resolution holes inspection system using image contact sensor.

System can detect deviations as small as 10 micrometers. It also acts as a coordinate measuring machine measuring holes position deviation compare to CAD data. Measuring results can be saved.

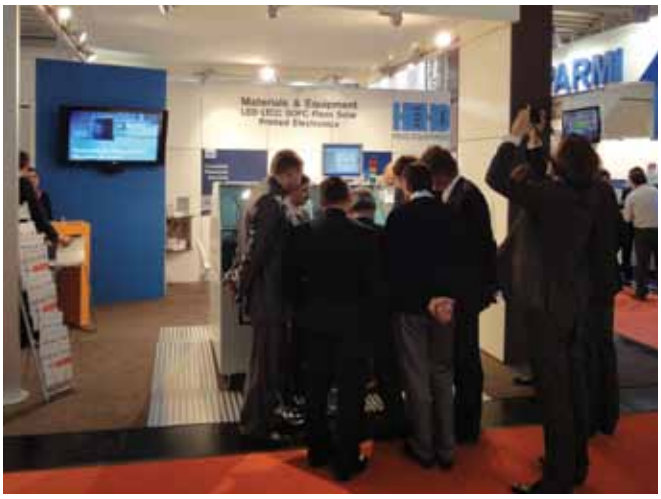
Consequently pouching process can be completely statistically controlled.

An offline version of punching quality verification machine for lab scale production, is also available.



Trade Fairs & Exhibitions

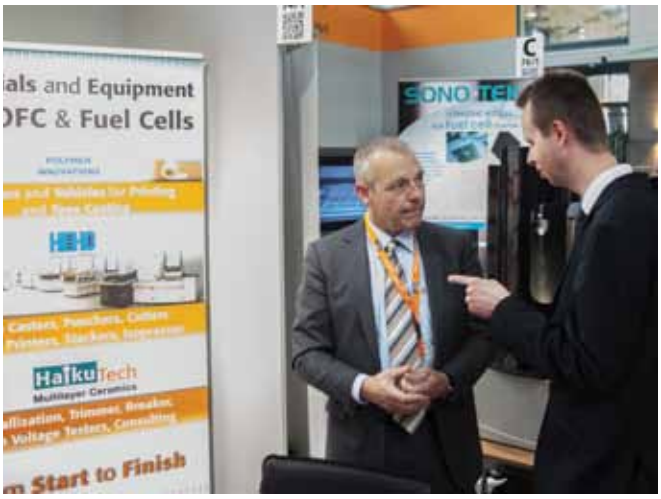
In 2011, 2012 and 2013 we were attending IMAPS 2013, Productronica Munich, Hannover 2012, Groove Fuel Cells Berlin and EXPO Moscow.



Productronica Munich 2011

Productronica Munich 2011

Groove Fuel cells Berlin



Hannover 2012

IMAPS 2013 - Orlando, FL

Expo Moscow 2013

KEKO EQUIPMENT

Standard Products Overview 2013

Slurry preparing

Roller benches
BL - series

- adjustable rotation speed and time
- adjustable to different jar sizes

Models:

BL-X
- **1, 3, 6, 8** Max. number of jars on rubber rollers
- **Roller bench**

Tape casting

Laboratory tape casters
L-series

- for laboratory or small production volume
- casting on PET film
- casting speed control
- gravity slurry feeding
- tape winding

CAM-L25xxx
- Bottom heating **(B)**
- Top heating **(T)**
- Dryer length **2, 3, 4** (m)
- **25** only - max. PET film width in cm
- **L**aboratory type
- **Casting machine**

Tape casting on polyester film

Compact tape casters
C-series

- compact size requiring minimum floor size
- suitable for solvent and water based systems
- high accuracy in thickness control
- automatic tracking of carrier film
- automatic slurry feeding
- applicable for up to 100 micron tape thickness

CAM-Cxxxx
- **L** - for 2 m longer dying section
- **B** - for base model without touch screen and automatic blade gap setting
- **25** or **35** -max. PET film width in cm
- **C**ompact type
- **Casting machine**

Tape casting on polyester film

Horizontal drying zone tape casters
H-series

- thickness 5-500 microns (0.2 - 2 mils)
- advanced drying regimes possible
- high accuracy in thickness control
- automatic tracking of carrier film
- automatic slurry feeding

CAM-Hxxx
- Drier length: 6 - 20 (m) (in 2m steps)
- **25, 35, 45** or **60** - max. PET film width in cm
- **H**orizontal type
- **Casting machine**

Tape casting on polyester film

Steel belt tape casters
S-series

- suitable for price sensitive applications
- diferent drying regimes
- high accuracy doctor blade
- automatic tracking of steel belt
- automatic slurry feeding
- tape winding

CAM-S30x
- Drier length **5 (7, 9, 11)**(m)
- **30** or **60** - max. steel belt width in cm
- **S**tainless steel belt type
- **Casting machine**

Tape casting on steel belt

Tape blanking

Automatic green tape blanker
SC-series

- blanks single sheets from a roll of green tape
- suitable for freestanding or Mylar based tapes
- trims sheet edges
- punch registration holes
- transferes blanked sheets to a magazine
- sorting blanked sheets acording to thair thickness

SC-25xxx
- **T**- sheet to tray, **C**- sheet to magazine (cassette)
- **N** - without registration punching, **P**- with punch tool
- **M** for tape on Mylar, **F** for freestanding tape
- **25** or **35** - max. Tape width in cm
- **Sheet cutter**

Tape punching

Punching machine
PAM-series

- punch holes for vias and registration in green tape
- punch cavity rectangle or square holes
- manual, CAD, NcDrill and DXF file input
- tool breakage detection
- automatic sheets re-alignment

PAM-xxx
- Tape handling - manual **M**
  - magazine to magazine **CC**
  - reel feeder to magazine **RC**
- **S**- single pin punching tools type
- **M**- multiple pins punching tool
- Number of tool position **(4 or 8)**
- Tools have to be specified separately
- **Punching machine**

Especially suitable for LTCC production

Screen printing

Screen printers
P - series

- Three models available to meet all requirements
- Fully programmable printing parameters
- Print/print, print/flood, flood/print, on contact print, stencil printing, via filling
- Extensive options for demanding advanced technology applications

Models:

P-xxx
- **VF** in case of via filling option
- **B** basic model, **S** standard model, **A** advanced model
- Printer size **200** or **400**
- **Printer**

Automatic screen printers
P-series

- Automatic sheet handling, printing, drying process
- Two models available to meet al requirements
- Fully programmable printing parameters
- Print/print, print/flood, flood/print, on contact print, stencil printing, via filling and screen cleaning
- Extensive options for demanding advanced technology applications

P-200xAM
- **A**utomatic **M**anipulation
- **S** standard model, **A** advanced model
- Printer size **200**
- **Printer**

Roll to roll printing

Automatic roll to roll screen printers
RTP-series

- Automatic screen printing on to tape from a roll, suitable for different application
- Advanced print alignment feedback
- Double color printing with precise alignment version
- Specially designed for MLCC high layers production
- Efficient tape drying- ensure short cycle time
- Printed tape tracking control on winding side

RTP-xx
- **S** -single print, **D**- double print
- **200** or **400** -printing width
- **Roll to roll printer**

Drying

Drier
SD-series

- dry single sheets, substrates or wafers after printing
- air flow ensure high drying efficiency
- adjustable internal and fresh airflow circulation.
- sheets are transported by teflonized mesh belt
- IR fast drying version available
- height adapted to Keko manual screen printers

SD-xxxx
- OPTION: Infra **R**ed drying **(IR)**
- **2 (4, 6, 8)** (m) - Drier lenght
- **30** or **45** - max. belt width in cm
- **Drier**

Cover sheets making

Cover sheets maker
CSM-series

- Makes cover sheets directly onto carrying palette from a roll of tape
- Glues the cover sheet to custom carrying palette
- Sheet blanker and press in one unit

CSM-xxx
- **C** - cassettes for carriers
- Foil type: **F** - **F**reestanding, **M** - **M**ylar
- Foil width: **25** cm max.
- **Cover Sheet Maker**

Stacking

Manual stacker
SM-series

-Simplified manual stacker
-Uniaxial lamination possibility
-Registration can be done by registration pins

SM-xxx
- Pressing force: **L** - low up to 200 kN, **H** - high up to 420 kN
- - no registration, **P** - pin registration
- Sheet size: **4**, **6**, **8** inch
- Stacker **SM** type

Universal stacker
SW-series

- Manual or automatic stacking machine for low to medium LTCC or other similar component production
- Suitable for tapes with or without carrier film
- Process on one carrier pallette
- Possible to start building stack from top or from bottom
- Vacuum press for bubbling sensitive foils

SW-xxxxx
- **V** - Vacuum press
- Pressing force: **L** - **L**ow up to 200 kN, **H** - **H**igh up to 420 kN
- Sheet alignment: **P** - **P**in, **V** - **V**ision
- Sheet loading: **M** - **M**anual, **A** - **A**utomatic from cassette
- Sheet size: **6**, **8** inch
- **Stacker SW** type

Stacking

Stacking machine
ST-series

- Automatic sheet loading from cassettes
- Carrier palette automatic loading / unloading
- Automatically removes carrier film first, than stacks
- Pre-registration is done by registration pins
- Automatic vision alignment
- Suitable also for very high layer count
- Not suitable for tapes with punched holes

Models:

ST-xxxx
- **P** - Carrier plates auto loading
- **C** - cavity, for high stacks, without pressing posibility
- **V** - vision alignment
- **P** -pin alignment
- Sheet loading: **M** - Manual, **A** - Automatic
- Sheet size: **4**, **6**, **8** inch
- Stacker **ST** type

Process on one carrier palette at the same time

Stacking machine
SB - series

- Automatic sheet loading from cassettes
- Carrier palettes automatic loading / unloading
- Pressing first than removing carrier film
- Pre-registration is done by registration pins
- Automatic vision alignment
- Suitable for high volume production
- Suitable for various components

SB- xxx
- **V** - vision alignment
- **P** - pin alignment
- Sheet loading: **M** - Manual, **A** - Automatic
- Sheet size: **6**, **8** inch
- **Stacker**

Standard 24 carrier block carousel transport

Printing & stacking

Print on stack technology

Printing and stacking machine
PAL - series

- Universal system for components up to 100 layers
- High productivity = low cost per component
- Suitable for smallest components size
- Uses carrier film tapes, freestanding tapes and individual sheets
- Special configurations like: -several printers
  -several driers
  -sheet vision alignment
  -other special requirements

PAL- xxx
- **M**- Mylar feeder
- **F**- Free standing tape feeder
- **S**- Sheet loading
- **1**, **2**, **3** Number of printers
- Sheet size: **6**, **8** inch
- **Printing And Laminating System**

Contact supplier for particular application

Laminating

Uniaxial thermal press
TPR - series

-Multiple stacks are laminated simultaneously
-High stack lamination possibility
-Simplified versions available
-Easy to operate, quick product turn-around time
-Rigid, compact design takes little floor space

TPR-xxx
- **C**- cavity for high stack lamination
- **F**- flat plates
- Pressing force: **L** - low up to 400kN, **H** - high up to 700 kN
- Max. bar size in inch: **4** or **6**
- **Thermal Press**

Higher forces on vacuum chamber on request

Isostatic lamination press
ILS - series

-Up to 40 stacks/substrates laminated simultaneously
-Wide selection range of bar size
-Easy to operate, quick product turn-around time
-Rigid, compact design takes little floor space
-Stores up to 99 pressure programs

ILS-xxx
- **D** in case of double chamber length (for ILS-6 only)
- Max. pressure **6** for 6000PSI (42Mpa), **10** for 10000PSI (70Mpa)
- Max. bar size in inch: **4** or **6** or **10** or **12**
- **Isostatic laminator**

Vacuum sealing device included

Cutting

Cutting machine
CM-series

- Cuts the most difficult high thickness green Ceramic Ware
- Automatically positions knife with high accuracy
- Automatically finds cutting markers
- Adjustable speed and cutting depth
- High productivity due to high cutting speed

CM-15xx
- **A** - Auto bar handling from/to cassette
- **M**- Manual machine without auto vision alignment
- bar size: **4**, **6**, **8**, **10** inch
- Cutting Machine

Pre and post heating plates optionally

Edge Trimmer
ET-series

- Simple, flexible and accurate
- Bar Edge trimming and Splitting posibility
- Laser pointers installed for precise block positioning

ET-xx
- - edge trimming
- **A** - edge trimming & bar splitting function
- bar size: **4**, **6**, **8**, **10** inch
- Edge Cutter

CNC drilling

CNC Milling machine
CNC-series

- Cuts any shape out of green ceramic
- Drills holes
- Automatically positions bar by vision system
- DXF file conversion
- Vacuum bar fixing
- Two spindle simultaneous operation option

CNC - XX
- D - Double spindle
- bar size: 6, 8, 10 inch
- Milling machine

Contact producer for detailed specification!

DM dipping

Dipping machine
DM-series

- Fully programmable dipping conditions ensures accurate and exellent termination
- Simple programming, more than 50 dipping programs can be stored
- Truth chip leveling mode ensure uniform dipping height
- High speed, high accuracy servo motors positioning
- Easy cleaning features

DM - 6
- Dipping machine

Contact producer for detailed specification!

Vacuum

Vacuum pump
VP-series

- For vacuum supply
- Consist of: vacuum pump, reservoir, electrical control with vacuum level switch switching pump on / off, vacuum filter

VP - X
- 300 Suction capacity
- 1000
- 1600
- Vacuum Pump

Materials and Technology

Based on experiences and cooperation with institutes in field of material and technology development, Keko Equipment new strategy is offering complete solutions for multilayer ceramic products, including compatible materials, technology and machines.
Please contact Keko equipment for particular solution.

09/13

Custom desiged machines

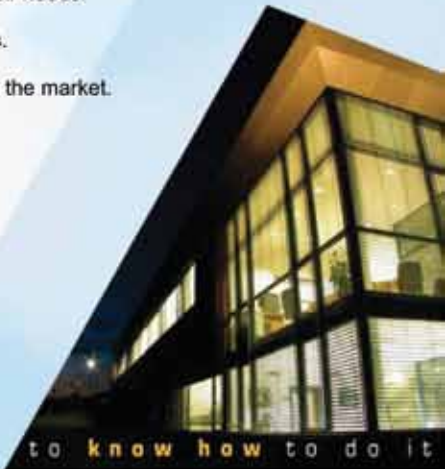
Our machines are developed, designed and produced in our house.

One of Keko Equipment strongest part is custom designed equipment basted on custom requirements and our long term designing and machines production experiences.

Many customers are satisfied with our innovative solutions adapted to their needs.

Experienced production team is guaranty for quality and success.

Contact us, if you are looking for custom solution, which you can not find on the market.



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Company Profile

KEKO Equipment Ltd. is a leader in the manufacture of machines for the production of multilayer passive ceramic components but also many other products, based on a tape casting process.

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

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