

Keko Equipment NEWSLETTER
NO. 3 **NOVEMBER 2005**



We are proud to present the third volume of our Newsletter, which is published every two years. It contains information about our accomplishments in the past two years and our plans for the future.

In the past two years we have further strengthened our market position, we've also expanded the range of applications for our equipment. It is our policy to continually listen to our customers; they've helped us to improve the existing equipment designs by making them more flexible and adding important new features to virtually every machine in our product line. I'm very satisfied that we successfully completed many custom designed projects, where we showcased our flexibility and fast delivery regardless of the complexity of the design.

We experienced a yearly growth of more than 15% in our sales in the past couple of years, mainly as a result of the discovery of new applications for our product line, including: LTCC, Piezo actuators and Solid Oxide Fuel cells. We have been receiving more and more inquiries for custom designed tape casting machines, leading us to believe that the applications for multi-layer ceramic technology will continue to grow and many new companies and research institutes will need to be equipped with a line capable of developing new products based on the tape casting and stacking-printing process.

These days we are celebrating the first 10 years of Keko Equipment. Back in 1995 our company was reincarnated into a specialized business to develop and produce equipment for the multi-layer ceramic industry. Many things occur in this period, including an extraordinary year 2000, but I am glad the situation has come back to normal levels in the last two years.

I hope every reader of this Newsletter finds something that might be beneficial for his or her company. Please remember that we welcome all suggestions, I'm sure most of them will find their way into future improvements or new designs. We are here to assist you; our engineers will work together with you in our fully equipped showroom to find the best solutions for your particular production requirements.

Tone Konda, General Manager

KEKO Equipment celebrates its 10th anniversary. Here are some important facts from our recent history:

- active promotion of our equipment in the Asian market since 1995
- Agency contracts for Korea, Taiwan, China and Japan were signed in 1996
- Agency contract for Europe and Americas was signed in 1998
- We moved to a new facility in 2001
- We successfully supplied more than 350 machines to customers all around the world, including:
 - o More than 40 tape casting machines
 - o More than 90 stacking machines
 - o 30 iso-static laminators
 - o 80 cutting machines
 - o 30 taping machines
 - o And many other machines used in the production of multi-layer components
- Some of the applications for our equipment include:
 - o Multi-layer ceramic capacitors
 - o Multi-layer inductors
 - o Chip varistors, PTC, NTC
 - o LTCC
 - o Piezo actuators
 - o Fuel cells
 - o And other similar products
- Our machines are installed at facilities from the most important producers worldwide.



Development Activities and Strategy

Jože Štupar, Technical Director



In the past Keko Equipment was mainly known as an equipment maker for the production of passive electronic components; nowadays we are entering into other industries.

Thin multi-layer and single layer ceramic technology is not only applicable in the electronic components making industry; it's also suitable for a wide range of diverse applications such as the automotive industry, the alternative electrical energy production, filtering, etc. In the last few years Keko Equipment has been involved in several big development projects, directly or indirectly supported by the European Union.

Due to our flexibility, knowledge and innovation, several prototyping and production lines have been successfully developed for different applications. These markets are becoming an important part of our activities. Some of these applications are described in this newsletter.

In regards to the passive components, the market trend in the recent years has been to integrate the

components. For these new LTCC components we can offer prototyping lines as well as fully production scale automatic lines. We closely work with our customers to adequately customize our equipment in order to fulfill their specific needs.

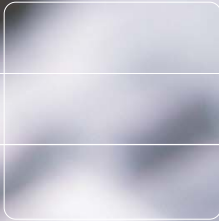
Equipment for classic passive electronic components production such as MLCC, MLCL, MLCV, remain very important to us. Our aim in this field is to continue to improve our machines and make them as close to perfect as possible. Requirements for smaller and smaller components, more and more layers and high productivity require hard work from all of our employees.

Sometimes hard developing work can not be paid enough; it is only compensated by our satisfaction and our newly acquired knowledge. In many cases we are a step ahead from our competition due to our innovative approach to solve the production challenges we are constantly faced with, and we are proud of our unique solutions, which are confirmed by many satisfied customers. It's our goal to maintain and continue to improve our international reputation, which has been mainly built as a result of our knowledge, innovation and flexibility.





Technology News



Automatic fuel cell electrode printer



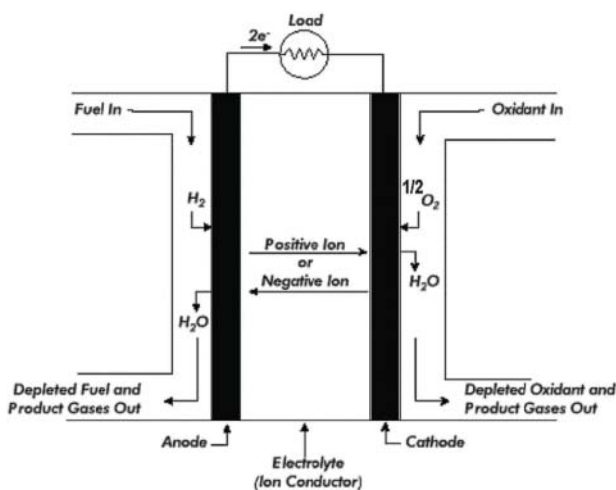
Green ceramic tape casting machine CAM-M1A

Looking for alternative energy Solid Oxide (High Temperature) Fuel Cells

Clean energy is a must for further human development, one option to offer environmental friendly energy is offered by the fuel cell technology. Keko Equipment has successfully developed a production line for the production of Solid Oxide Fuel Cells.

What is a Fuel Cell?

Fuel cells are electrochemical devices that convert the chemical energy of a reaction directly into electrical energy. The basic physical structure or building block of a fuel cell consists of an electrolyte layer in contact with a porous anode and cathode on either side. A schematic representation of a fuel cell with the reactant/product gases and the ion conduction flow directions through the cell is shown:



The fuel cell is an energy conversion device that theoretically has the capability of producing electrical energy for as long as the fuel and oxidant are supplied to the electrodes. In reality, degradation, primarily corrosion, or malfunction of components limit the practical operating life of fuel cells.

A variety of fuel cells are in different stages of development. They can be classified by use of diverse categories, depending on the combination of type of fuel

and oxidant, whether the fuel is processed outside (external reforming) or inside (internal reforming) the fuel cell, the type of electrolyte, the temperature of operation, whether the reactants are fed to the cell by internal or external manifolds, etc. The most common classification of fuel cells is by the type of electrolyte used in the cells and includes 1) proton exchange membrane (polymer) electrolyte fuel cell (PEFC), 2) alkaline fuel cell (AFC), 3) phosphoric acid fuel cell (PAFC), 4) molten carbonate fuel cell (MCFC), and 5) solid oxide fuel cell (SOFC). These fuel cells are listed in the order of approximate operating temperature, ranging from ~80°C for PEFC, ~100°C for AFC, ~200°C for PAFC, ~650°C for MCFC, and 800°C to 1000°C for SOFC. The operating temperature and useful life of a fuel cell dictate the physicochemical and thermo mechanical properties of materials used in the cell components (i.e., electrodes, electrolyte, interconnect, current collector, etc.).

The production line developed by Keko equipment is for production of the so-called high-temperature or solid oxide fuel cells (SOFC).

The electrolyte in this fuel cell is a solid, nonporous metal oxide, usually Y₂O₃-stabilized ZrO₂. The cell operates at 650 to 1000°C where ionic conduction by oxygen ions takes place. Typically, the anode is Co-ZrO₂ or Ni-ZrO₂ ceramic, and the cathode is Sr-doped LaMnO₃.

High-temperature fuel cells, unlike other types, are capable of producing electricity and heat not only from hydrogen or methanol but also from cheaper and more readily available energy sources such as natural gas, gasoline, diesel or biogas. A front-end reformer converts these fuels to hydrogen and carbon monoxide. But the high operating temperature of over 800 °C requires a correspondingly long period of pre-heating. For that reason, such fuel cells are best employed in situations where they continuously operate – particularly providing energy for buildings and vehicles.

Production of high temperatures fuel cells consist of following steps:

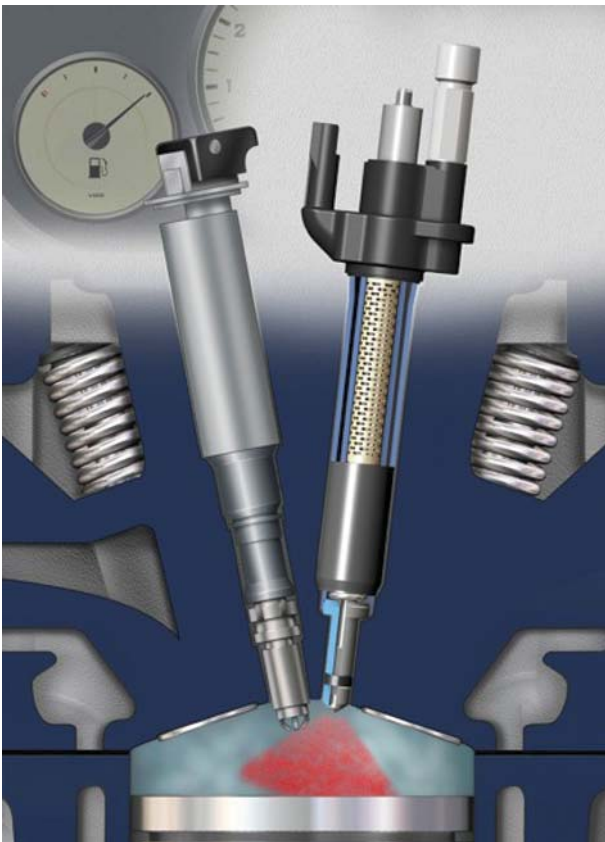


Piezo injectors in diesel and gasoline engines greater improve fuel-efficiency

The piezo-based injection system improves fuel efficiency, combustion and exhaust gas after-treatment.

High-pressure multiple fuel injections in precisely metered dosages and in correct spray shape is the primary focus of diesel engine manufacturers for the development of cleaner, quieter and fuel-efficient diesel engines.

Nowadays piezo injection is gradually replacing the solenoid injection.



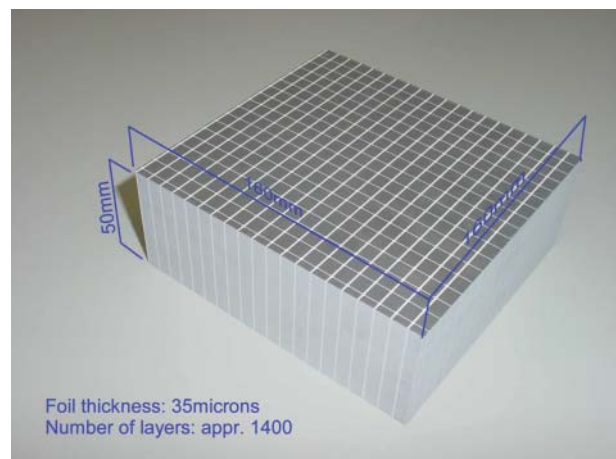
Piezo ceramic crystals generated a potential difference across the opposite faces as a result of application of mechanical stress between these faces. The electric polarization produced is proportional to the stress, and the direction of the polarization reverses if the stress changes from compression to tension.

This effect is also reversible. If the opposite faces of the crystal are subjected to a potential difference, the crystal lattice changes within a few milliseconds resulting in expansion or contraction giving a change of shape, thus producing enormous force for actuating a valve by physical contact and elastic coupling. Solenoid is a magnetic technology and is based on a force that arises

at a distance. Piezo actuators can be designed to replace any solenoid but they always come out bulkier. On the other hand, they take much less power to operate. With the discovery of new piezoelectric ceramics, the designers can actually tailor the material for a definite purpose. The greatest advantage of is the speed compared to solenoid valves. Multiple injections are designed to produce clean and efficient combustion without a steep pressure rise, which results in quieter operation.

Expansion or contraction of a single piezo crystal is very small. In order to achieve the required stroke piezo injection actuators consists of many layers (more than 1000); in this way the actuator stroke can be over 1 mm.

Keko Equipment is a worldwide leader designer and producer of equipment to fabricate multi-layer based ceramic products. Together with a leading European automotive parts' supplier we've successfully developed machines and procedures to produce piezo ceramic stacks, suitable for the fabrication of piezo injectors. These stacks consist up to 2000 individual layers.





Software gives life to the machines

One of our most important competitive advantages is our capability to develop our own software for machine control and production inspection. Based on this knowledge we now have the possibility to offer simple and effective custom solutions to our customers. In this article we would like to introduce three PC based software solutions, which could help our customers in their production processes.

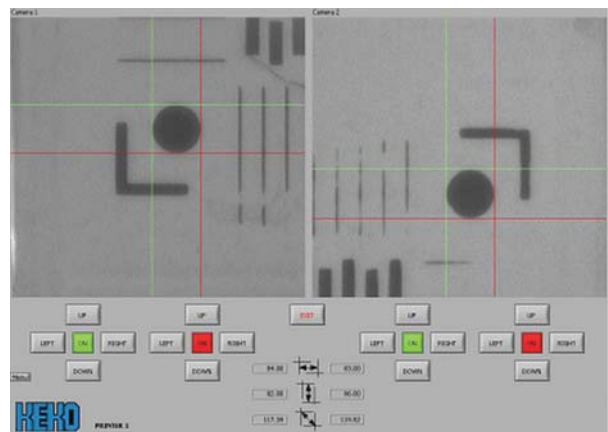
1) Camera cross hair generator

The camera cross hair generator is a simple but useful utility; it helps the operator to manually align the substrates on screen-printing machines, stackers or other machines where precise manual alignment is required.

Most cross hair generators available today use analog cameras, a splitter and one monitor or several monitors with many cables. This combination results in an expensive solution with limited capabilities. Our camera cross hair generator software can be used on any PC with the possibility to connect fire-wire or USB2 digital cameras. Up to four cameras (usually two) can be connected in order to observe up to four different areas. One or two line type crosses can be generated on the PC monitor. Some measurements, like length between two crosses and a rectangular area can be measured in our system, similar to a digital microscope.

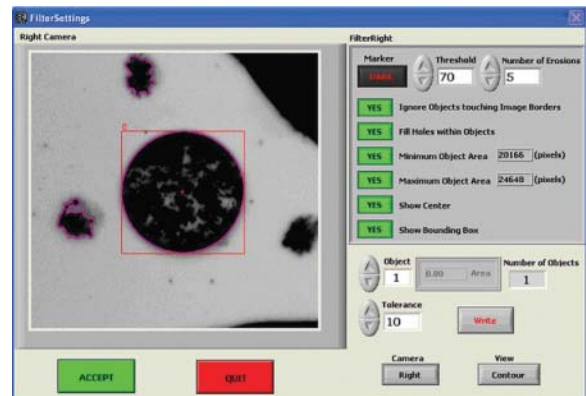
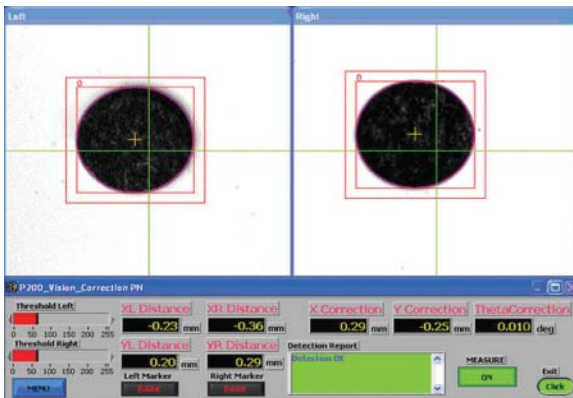


Cross generator software installed on one of our screen printers.



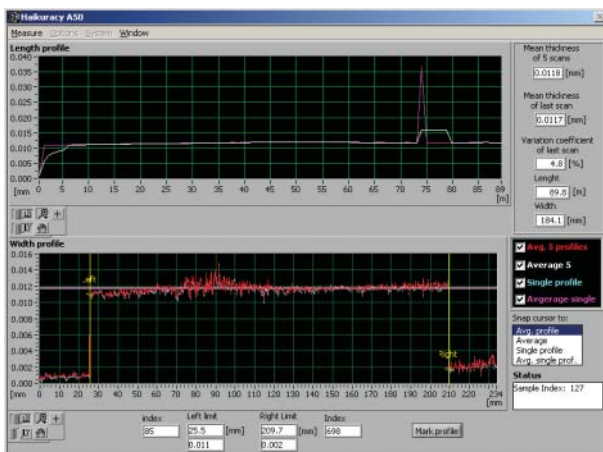
2) Computer vision recognition and automatic alignment

In order to achieve accuracy and repeatability, an automatic vision marker recognition and alignment system is a must in modern electronic component production. Keko Equipment offers a state-of-the-art automatic vision alignment system. It has been installed on many of our screen printers, stackers cutting and punching machines. It allows for reliable marker recognition and marker position detection. The marker can be a hole, a printed mark or any other shape. Numerous adjustment possibilities make it a universal tool for either position detection or quality inspection, e.g. to inspect the quality of vias after they are formed (punched).



3) Laser Thickness Measurement

The laser thickness measurement unit has been developed in order to measure green ceramic tape thickness during the tape casting process. It can be adapted to operate on either our CAM-M1 or CAM-22 tape casters. The tape is scanned over the width in pre-programmed intervals. The measurement resolution is in the range of 1 micrometer. Sophisticated software was specially developed that includes numerous statistical functions in order to have statistical data over the complete width and length of the tape. All process and statistical data can be observed on a PC. Limits of tape thickness can also be set. Calibration is fast and



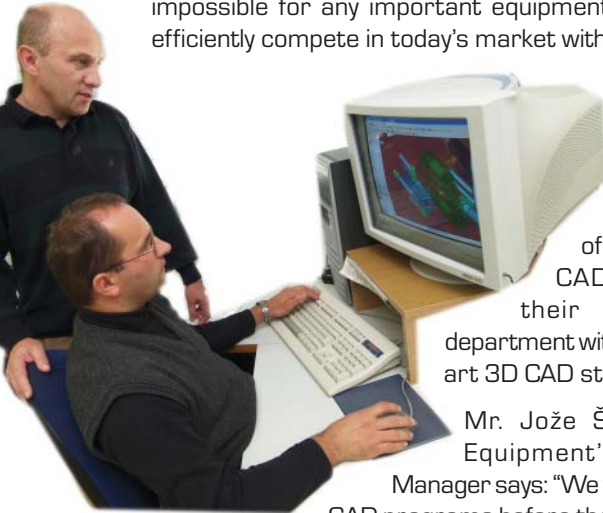
Laser thickness measuring installed on CAM-M1 casting machine

easy. Keko Equipment's laser thickness measuring unit offers an ideal solution for accurate tape casting thickness control.



Investment in CAD/CAM and CNC technologies

The performance of the latest generation of 3D CAD programs has reached such a level that is practically impossible for any important equipment producer to efficiently compete in today's market without them.



Within the past year Keko Equipment has replaced all of the older 2D CAD stations in their design department with state-of-the-art 3D CAD stations.

Mr. Jože Štupar, Keko Equipment's Technical Manager says: "We tested several CAD programs before the decision was

taken, in the end we chose Solidworks as the most suitable program for our applications. After just one year of using Solidworks we've seen many advantages in using 3D design technology instead of the old 2D programs, now there are fewer mistakes in the design stage and the design to final completion time has been reduced. One great advantage for the designers, especially the younger ones, is that they can easily preview how a machine will look, the machines practically grow in their computer monitors and the results are instantaneous."

Mr. Štupar continues his comments: "Another important advantage is Customer Support. Many of our machines are custom designed and the customers can get a realistic 3D view of the machine immediately after the design is finished before it's entered into production."

Keko Equipment has invested more than 500.000 Euros in order to bring the advantages of 3D CAD design and newer CNC machinery into the company.

One very important strategic point that Keko Equipment has is the ability to fabricate most machined parts in house; this allows for more flexibility and shorter deliveries compared to the competition. "Today we are producing over 80% of all machined parts on our CNC machines. I think that today there is no other alternative than using CNC machines for parts' making. The parts made on the CNC machines are produced faster, more accurately and the machine never complains", Mr. Štupar said.



LTCC production highlights

Punching machine PAM-4/8S

Our punching machine was introduced two years ago and the market acceptance has been extremely positive. Several advantages like ease of punching tool replacement, advanced software, tool breakage control, fast operation and affordable price make it a very attractive unit. In the past two years we've developed numerous options, i.e. automatic tape feeding from a roll, automatic sheet feeding from cassettes, multiple pin punching tools, etc.

This system is capable of forming micro vias as small as 50 micrometers in diameter (in ceramic tapes) at a speed of 13 punches per second. In the very near future a linear motor driven version will be available in order to achieve higher punching speed and even quieter operation



Automatic LTCC tape printing using P-200AV printer

An automatic sheet handling system has been added to our successful P-200AV printer. Ceramic sheets are placed in a cassette, from the cassette the sheets are automatically picked up and placed on a registration table where the alignment is done by an automatic computer vision system, then the sheets are screen printed or vias are filled, the printed sheets are placed in the SD-3 dryer. Once the sheets exit the dryer they are automatically collected back into the cassette.



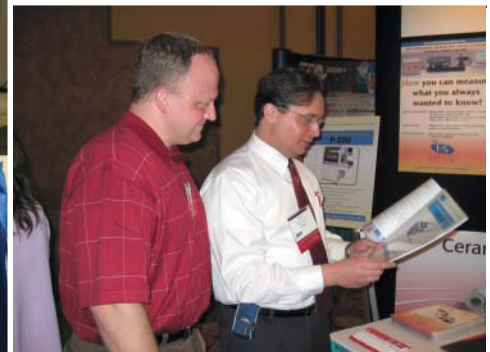
Automatic vision alignment LTCC tape stacker IS-3AV

The IS-3AV stacker is the most advanced and competitive machine in the market today for mass producing LTCC parts. It automatically stacks up to 20 different sheet patterns to form a monolithic LTCC block. This unit can process ceramic tapes with or without carrier film. Sheet alignment is done by a vision system (developed in-house) with a precision in the range of ± 5 micrometers. A newly developed unique carrier film removing system removes the carrier film from the tape. The stacking press force is fully programmable.



Trade Fairs & Exhibitions

Snapshots from ACERS 2004, Advanced Ceramics & Composite Show, CARTS 2004, CARTS 2005, FUEL CELL 2005, IMAPS 2004, IMAPS 2005



SHOWCASE

Production line in Nanyang, China, manufactured by Keko Equipment

A complete line manufactured by Keko Equipment for the production of multi-layer low voltage suppressors was successfully put into operation in China.

- After long negotiations the contract was signed on June 2003.
- The line provided by Keko Equipment covers most of the processing steps, i.e. slurry preparation, tape casting, printing, stacking, final lamination, cutting, end termination, testing and packing.
- Technological support was given by Dr. Marija Trontelj and the Jozef Stefan Institute from Ljubljana, Slovenia.
- Successful training was provided at Keko Equipment's facility in Slovenia for a group of 10 engineers during one month.
- Additional training was given at the installation site, including technology support for the complete production line.
- The new factory was open in China on November 2004.
- Further technology support continues to this day.



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 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.



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