Fabrication Service Business (LASER & MEMS & Electroforming)

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Business Concept

1. KLT main business is the premier turnkey foundry/fabrication services and provides a great expert in NEMS/MEMS and Laser micromachining, Electroforming/Nanoimprint fabrics.

2. KLT provides the development and fabrication services of customers products of next generation in the following industries:
   * Si, Glass processed wafers and TGV/TSV interposers
   * NEMS/MEMS sensor components
   * Solar cell substrates & modules
   * 5G Data/Telecommunication components
   * Biomedical components
   * Electronics, Display, Semiconductor components
   * 3D Laser micromachining parts
   * Nano/Micro Electroforming components

3. With the ability to scale from single unit quantity to millions of parts, KLT provides a full spectrum of services to accommodate the customers in any step of their product development.

4. KLT has fruitful orders record and is more aggressively expanding this service and actively introducing the versatile accurate fabrication technologies in the world.
Target Market

1. Semiconductor
2. AI & IoT
3. Data/Telecommunications
4. Biotechnology & Life Science
5. Laser Micromachining
6. Photonics & Electronics
7. Aerospace & Military
8. Display
9. Solar & Photovoltaic
10. 3D Sensing/Imaging Sensors
Applications

1. TSV/TGV interposers
2. MEMS Probe card & parts
3. Nano/Micro structuring & drilling for Si, Glass wafer/substrate
4. Microsieve, microfilter, membrane
5. Mixed Reality (Augment Reality, Virtual Reality) and Lidar parts
6. MEMS sensors
7. Optoelectronics/Optophotonics
8. Microfluidic devices; Organ-On-a-Chip, Lap-On-a-Chip
9. Micro Optics for 3D Sensing/Imaging
10. SEM/TEM microscope parts
11. Electroforming/Nanoimprint molds & products
12. Solar/Photovaltaic substrates & modules
13. Fine Metal Mask for OLED
14. Biomedical components
15. 5G Data/Telecommunication components
16. 3D Laser-based Micromachining components
17. Special accurate material processed parts
Micro Optics
For 3D Sensing/Imaging
Micro Optics (DOE & MLA Diffuser) Features

1. KLT micro optics convert a typical incident light wave into a light wave having a desired wave-form and enable to perform functions such as focusing, diffusing, image generation, hologram, and color separation so on.

2. As a starting point, with the adoption of Apple’s facial recognition of 3D depth sensor, the other smartphone makers should apply for this technology and it is expected to grow rapidly the future Game, MR/AR/VR, Security, Autonomous Vehicle as the most powerful mobile ecosystem platform.

3. KLT provides the master molds by the laser direct writing and any special photolithography technologies for 3D geometric micro optics to enable 3D DOE (Diffractive Optical Elements) & MLA (Micro Lens Array) Diffuser and Dry Adhesive devices the extremely precise, miniaturized performance.

4. KLT provides any completed OEM/ODM WLO (Wafer Level Optics) & chips to overcome the limited conventional optics design with excellent quality/cost.

5. KLT provides Master wafer, molds, Ni-Shim, components, Turn-key Modules of laser+DOE/MLA, 3D Algorithm, and optics design service independently.

KLT provides 3D Core Display & Sensor Components
KLT’s Micro Optics Business Scope

1. Master Molds (Wafers) & Stamp/Template molds; 6”, 8” (Aspherical & Hemispherical Micro Lens Array, DOE, Special structures)

2. Wafer Level Optics (WLO) & Chip devices capability; Max. 10KK chips monthly for mobile 3D sensing

3. Dry Adhesive Devices with high aspect ratio; >10:1

4. Turn-Key Customized Modules Provider; Laser+DOE/MLA with 3D Algorithm.

5. In-house Optics design & prototype, high volume products

6. Individual fabrication services; Mold, Ni-Shim & Stamp supply
KLT’s Laser Direct Writing Fabrication Service

<Applications>
1. Prototype and master wafers fabrication service
   - 3D Sensing Optical DOE & Diffuser Parts
   - Light Field Optical Parts
   - Precision Laser Optical Parts
2. Biomimicry Parts
3. Precision 3D Structured Surface
4. Dry Adhesive Devices
Master Wafers & Molds

Polymer master and Nickel shim

Fresnel lens

Corncube retro-reflector

Hemispherical microlenses with 100% filling factor

Pyramidal micro-optics

Half-spheres
Functional Structured Micro Optics & Devices

- **Fresnel Lens** (Silicon)
- **Micro Lens Array** (Polymer on Glass, QZ)
- **DOE** (Polymer on Glass, QZ)
- **Dry Adhesive** (PDMS)
<Applications>
1. 3D Sensing Optical DOE & Diffuser Parts
2. Light Field Optical Parts
3. Precision Laser Optical Parts
4. Biomedical Optics Parts
5. Precision 3D Optical & Mechanical Surface Parts
6. Dry Adhesive devices
Scattered Dots DOEs for Mobile 3D Sensing

<LD Random Scattered Dots DOE> <VCSEL Scattered Dots DOE; Regular Matrix>

<VCSEL Scattered Dots DOE; Differential> <Diffuser>
WLO & DOE
DOE Modules
Diffuser

Diffuser (DOEs)

Vertical Cavity Surface Emitting Laser (VCSEL)
Mixed Reality (MR) & VR, AR

<table>
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<tr>
<th>Applications</th>
<th>Sensors</th>
<th>VR headset</th>
<th>AR Headset</th>
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<td>Position sensor</td>
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<td>2D camera</td>
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Dry Adhesive Devices (Micro LED Transfer)
Recognition Optical Sensor
Lidar

Beam divergence

Lidar

Radar
Fine Metal Mask
OLED Metal Mask Business Concept by KLT Laser Technology

Prospective Laser FMM Micromachining System Sales and Job Shop

1. Patent pending for Laser FMM Micromachining system
   Highest hole processing speed of multiple X10 comparing to the conventional laser technology; 500 holes per second

2. Highest performance developed laser FMM micromachining system by KLT

3. Laser FMM price with lower 30%-40% against chemical etching
   Lowest processing fee comparing to the high cost conventional chemical etching methods that have been exclusively supplying by a few Japan makers.

4. OLED display makers are looking for more FMM makers who can steadily supply with the inexpensive price and the laser FMM could be one solution.
   From this year, BOE China OLED display maker complete to set-up the flexible OLEDs of smart phone displays which were monopolized by Samsung in the world. A big issue of their some is to buy or make the lower price FMM to survive from the other 12 China OLED makers as a core component. The flexible OLED display market should be explosively expanded by Apple, China smart phone makers OLED adaption and the other applications; AR, VR, Wearables.

5. KLT FMM laser micromachining can be the best choice to take the lowest FMM price.
   KLT has a laser business cooperation with some major OLED makers and has been supplying the laser-tested samples and ready to sell the laser systems.
1. Application; Fine Metal Mask by Laser Ultra Precision Drilling → Replacing the conventional technologies for medium & small sized OLED substrates
2. Metal substrate; Invar, SS so on
3. Metal thickness; 5-30um
4. Hole size; Min. 5um
5. Work piece size (X,Y); 300 X from over than 1,000mm
6. Hole positioning accuracy; +/-1-2um
7. Hole drilling speed; 500 holes/second
8. Highest quality & FMM price of 30%-40% cheaper than etched products
1. Highest speed hole process; 500 holes/second for any shape holes
2. Hole position accuracy; +/-1-2um
3. Metal thickness; 5-30um
4. Hole size; Min, 5um
5. Working area (X,Y); 300 X from over than 1000mm
6. Option; Roll to Roll automatic system
7. Highest holes quality, simple operation with any patterned programs, short set-up time
Electroforming Hole Drilling (OLED display; Fine Metal Mask)

<Features>
- Apply for Medium & Small sized substrates
- Low thermal expansion
- Nano & Micro size Holes & Tapered side wall
- Spiral pattern deposition
- Lithography + Photo-Electroforming technology

<Application>
- Vapor-Deposition of OLED
- Patterning Electrodes of LED
- Patterning Electrodes of ITO film
1. Deposition masks are used for PVD-processes (sputtering, vapor deposition)
2. This shadow masks are applied e.g. for the deposition of metal electrodes on polymer, glass or ceramic substrates.
3. Vertical, burr-free edges with a low surface roughness
Electroforming/Nanoimprint
Micro-Filter (MEMS Microphone & Microspeaker)

<Features>
1. Highest effective profile mechanism---&gt;Ex) Trumpet shape profile with micron hole sizes
2. Highest acoustic characters by acoustic impedance control
3. Highest efficiency performance to protect any dust and particle for long time using
4. Best particles protection on PCB mount soldering assembly
5. Excellent sound quality and intelligibility in far field applications
6. Hole size; about 1-3um entrance and exit sizes
7. Nickel or Silicon based metal micro-filter of less 50um thickness
8. Any specific shape and size Micro-Filters on the customers’ request; EX) Nanorollimprint, Seamless Sleeve, so on
Micro-Filter (MEMS Microphone & Microspeaker)

Trumpet profile  Cylinder profile  2-step profile

Micro-slot filter  MEMS Microphone
Stealth Fine Sieve & Nozzle Plate

<Features>
- Tolerance ex: +/-0.5um
- Higher opening size; Min 300nano
- Long life by support structure
- Nozzle plate thickness should be about 10 times larger than the micro-hole diameter

<Application>
1. Sieve; Sieving of Solder ball, Diamond, CMP powder, ACF ball, Spacer ball, Carbon, Chemical compound
2. Nozzle plate; Nebulization of liquids and creation of aerosols
Metal Mesh

<Features>
- High accurate, high opening
- Various surface treatment
- Anticorrosive material is available

<Application>
Ink-jet printer (filter, orifice), medical filter, cell filter/trap, sieving, optics, optical aperture, optical slit
Relative Products

<Inkjet Nozzle Plate>

<Test Contactor>

<Flow Disk>

<Nebulizer Aperture Plate>
Nano/Micro Structures

- Optical Grating
- Hydrophobic Structure
- Optical Grating
- Diffuser Structure
Nanoimprint tools for large area and seamless imprint

1. Homogeneous, large format origination up to 1m²
2. Seamless on flat substrates
3. Seamless on curved surfaces and cylindrical sleeve substrates
4. Perfect periodicity
5. Antireflection structures (moth eyes)
6. Diffractive gratings and bionical grid-structures
7. Customized stochastical surface diffusers with highest transmission values
8. Combined structures (e.g. antiglare combined with antireflection structures)
Solar Cell Modules
No Battery Solar Cell Modules for Battery-Powered Sensors

1. Features; KLT completed the line-up production of Dye Sensitized Solar Cell (DSC) electric power modules for Battery-Powered IoT sensors on indoor environment and some worldwide major Beacon/Sensor makers are launching their new models with our DSC modules adoption.

2. Advantages
- Noble product & maker image upgrade by a new solar cell concept.
- KLT’s permanent No Battery DSC modules have been replacing the 1st batteries of various IoT sensors with the highest performance.
- Saving the labor charges and times for the irregular troubled battery exchanges
- No needed battery exchanges for the dangerous, high tall & crowded open space positioned sensors by the initial one time installation

3. Applications
- All Battery-Powered IoT sensors (Beacon, Vision sensor, Security sensor so on)
No Battery DSC Modules Line-Up
Outdoor DSC Modules

DSC Modules with 300 X 300mm (STD) size and various colors & decoration graphics for the building & interior glass windows of indoor & outdoor solar power applications
Outdoor DSC Modules Line-Up

Orange                     Green                   Red
Laser-Drilled Glass & Si Wafer/Substrates
Laser Drilled Glass Wafer

1. Interposer substrates for 3D IC interposers and RF components
2. Cover glass component within CMOS image sensors
3. Wafer Level Optics (WLO) sensors and detectors
Laser Drilled Silicon Wafer

High quality laser hole processing onto Silicon wafers of a few micron hole sizes
MEMS Glass Wafer

- **Appearance of Wafer**
- **Hole Shape**
  (Adjustable as Customer’s Demands)
- **Cross Section of Hole**

- **Specifications**
  - **Size**: Up to 9 inches
  - **Depth**: 0.3 ~ 3.0 t
  - **Diameter**: Ø0.3 mm □0.3mm 以上
  - **Hole Angle**: Adjustable as Customer’s Demands
  - **Materials**: TEMPAX, Sodalime etc
  - **Dimensional tolerance**: ±0.05 mm
  - **Roughness of surface**: Ra 0.05 μm 以下
KLT offers a variety of custom multiple hole Glass/Sapphire carriers wafer for TSV processing of GaAs, Indium Phosphide, Silicon and other semiconductors. They are the material of choice due to its durability, transparency, hardness and chemical and scratch resistance.
Glass Cavity/Cap/Spacer

Transparent cavity
+ sidewall metallization

Wafer image

Enlarged view
TGV Interposer with Cu Electric Filling

60 micron diameter through glass vias at 120 micron pitch

Polished cross-section of copper filled through glass vias

Power amplifier electronic package

10-20 mil thickness and < 25µm via diameter
TGV Interposer for Semiconductor
1. 62% reduction in product size compared to the PCB analogue eliminating PCB boards
2. 28% reduction in total power consumption
TSV Interposer

TSV technology has been using in several components fabrication

1. Large-scale 3D integration
2. 140,000 hermetic metal filled TSVs per wafer
3. Reducing routing complexity and increase integration
4. Copper TSV can dramatically improve electrical performance
5. Up to 25:1 aspect ratio
6. 90 +/- 1 degree sidewall angle
7. Useful for etching of close-tolerance comb fingers, vias or holes and trenches
8. KLT can supply OEM TSV interposers
TSV Interposer
Optical Communication
Multi-Chip Module by Photonic Wire Bonding (PWB)

KLT is providing Laser-Based 3D nano-fabrication PWB technology

1. KLT proprietary photonic wirebonding technology allows to merge the specific strengths of different photonic integration platforms in a hybrid multi-chip system. Connecting InP lasers to silicon photonic chips, to low index-contrast Planar Lightwave Circuits (PLC), or to optical fibers.

2. Photonic chips and optical fibers are mounted on a common carrier and embedded into a photosensitive photoresist. Photonic wire bonds are then written in the volume of the resist by two-photon polymerization. The wire bonds can have arbitrary 3D shapes. This eliminates active alignment even for nano-scale single-mode waveguides and enables perfect matching of mode field sizes.

3. This 3D nano-fabrication technology and processes are geared to address key challenges of large-scale photonic integration and system assembly, serving applications in information and communication technology, in life sciences, as well as in industrial measurement and sensing.
PWB Configuration on Multi-Chip Module

(a) 3D structuring by two-photon polymerization
Photonic wire bond

Chip 2
Submount

(i) InP laser
Emission
Printed freeform lens
50 μm

(ii) Grating coupler

(iii) Beam expander

InP laser
Silicon photonic chip

Single-mode fiber array

Submount
Sample pictures; Connection between a silicon photonic chip and an InP-based horizontal-cavity surface-emitting laser
5G RF Filters

<1.0 dB of insertion loss for frequencies at 5GHz and 28GHz!
1. Small, ultra thin, Integrated Passive Devices (IPDs) for 5G (5GHz and 28GHz) applications
2. High-Q components ensure low insertion loss
3. Bandpass, lowpass, matching networks, and many other designs
4. Fully integratable into a RF System-in-Package for greatest performance
3D Embedded Waveguide

<3D photonic device in optical telecommunication>  <19 Channel & A conceptual image of photonic source>
KLT’s Fiber Coupled Interconnect is a 3D unique channeled glass interface designed to enable simple coupling to arrays of emitters or receivers including VCSELs / PDs or PICs.
Optical Fiber Glass Placement

Optical Fiber Placement with precision holes; 0.122mm diameter in 1.0mm Glass thickness
Fiber Optic Trench

A 100 micron deep fiber optic trench ending into a 45 degree vertical turning mirror

- Mechanical spacers
- Single-mode and multi-mode fiber optic alignment chips
- Fiber-to-Chip Optoelectronics
- Chip-to-chip Optoelectronics
- MOEMS
- Optical windows

Cross section of a 100 micron deep and 150 micron wide fiber optic alignment trench

30 degree angled through glass vias (TGVs) in 1mm thick glass.
Fiber Optic Hole Drilling

1. Profiles of the hole: circle, square, rectangular
2. Diameter: from 10 μm.
3. All type of optical fibers.
Micro-optics on Optical Fiber Tip

1. Lenses, prisms, gratings, spiral phase plates, 2D/3D gratings
2. Resolution: 100 nano to 20 μm.
3. All type of optical fibers.
4. Applications; Beam formation and coupling
MEMS Probe Card
KLT Business for MEMS Probe Card

KLT has been supplying OEM MEMS Probe Cards and parts in the World

1. OEM supply for MEMS Probe Card Assembly
2. Plates; OEM supply for Ceramic, Quartz made by KLT design and Laser micromachining
3. MEMS standard and 2.5G & 3.0G probe pin; OEM metal pins supply by KLT design and X-Ray lithography + Electroforming technology
4. Wire Space Transformer and PCB; OEM supply by KLT designed high quality parts
5. OEM supply for Cantilever probe cards

KLT premium OEM supply for MEMS probe card & part
Why MEMS Probe Card Plates made by KLT Laser?

KLT is the Best OEM Provider for Laser Probe Card Plates

1. Material; SiN, Quartz (Fused Silica), BoN
2. Material thickness; 0.1-0.5mm
3. Hole size; Min. 20um round hole and Min. 20 X 20um square hole
   Aspect Ratio; Max. 1:50
4. Hole size and positioning accuracy;
   Min. +/-1um
5. Clean hole edge quality process by 3D laser technology
6. Lower price, high quality, short delivery from the proto to high volume products

KLT is the Best OEM Provider with the Laser Ultra-Precision Process
MEMS Probe Cards---KLT OEM Supply

PMIC Probe Card
- 4 Para
- 55um Pitch
- Area Array

CIS Probe Card
- 16 Para
- 85um Pitch
- C-type
- 1.5GHz (MIPI 적용)

3D-IC TSV P/C
- 1 Para (Wide I/O)
- 50x40um Pitch
- Area Array
- 1,386 Pin

3D-IC SoC Type
- 1 Para
- 186x186um Pitch
- Area Array
- 10,000 Pin

DRAM Probe Card
- 300mm, 528 Para
- Min 70um Pitch
- 37,000 Pin
- 6TRE, 2 Touch
<Features>
- Probes Pins (tips) with super elastic and super reliability can be applied to the next generation probe system by high accuracy and functions through X-Ray lithography & Electroforming technology
- Various Material (mechanical, electrical); High frequency
- Various Design Capability (needle, vertical, blade)
- Higher durability (burn-in, abrasion); Over than 10,000,000

<Application>
MEMS Probe for 2.5G, 3G
MEMS Probe Card Plate (Ceramic)
MEMS Probe Card Plate (Ceramic Hole Shapes)
MEMS Probe Card Plate (Quartz)
MEMS Probe Card Head (Square hole microscope picture)

<40um square holes with 4 corners R; 5um on 0.2mmTK glass>
BioMedical
Laser-Based 3D Microfluidic Chips

Novel Microfluidic Technology Features

1. Our novel microfluidic technology is giving the opportunity to engineers to explore the third dimension, add feature-sized complexity and integrate optical, mechanical, physical or even electrical functionalities to the microfluidic device, resulting in higher performances and disruptive applications in single glass monoliths.

2. Deposition of metals to create embedded electrodes, surface functionalization to form hydrophobic or hydrophilic surfaces, or coupling waveguides to structure optofluidic devices are some of the examples of integration in glass lab-on-chips. Our more sophisticated devices, operating at high temperature above 80°C and with a maximum pressure above 40 bars, benefit from glass exceptional resistance to heat and stress.

3. Our low-temperature manufacturing platform allows the fabrication of leaktight lab-on-chips with an alignment precision of 2 microns and geometrical precision of 1 micron. The result is a glue- and chemical-free process, avoiding imaging loss of quality and sample contamination.

4. Any space limited applications could also benefit from the integration of connection ports directly into the microfluidic chip, following at the same time the standardization guidelines as per port size, positioning and port coding with the below 5 microns along the depth.
3D Complex Lab-On-Chip

3D Complex Lab-On-Chip (Min 3um channel diameter)
Microfluidic Mixer; 5 inlet and 1 outlet with 100um channel diameter
3D Microfluidic Chips Samples (Glass)
3D Microfluidic Chips Samples (Polymer)
Low Cost Glass Microfluidic Chips
Biomimicry structures; Imitate nature to create complex microfluidic and biological treatments, biocompatible skin adhesives so on.
SEM/TEM Apertures Supply

KLT has been supplying Laser Ultra-Precision Drilled SEM/TEM Apertures

1. Molybdenum & Platinum-Iridium Apertures Supply for SEM/TEM by Laser Ultra Precision Drilling → Replacing the conventional Photo-Mask Etching by High position accuracy and hole quality demand
2. Thickness; from 20um
3. Hole size; from 5um
4. Hole position accuracy; +/-1um
5. Big sales record of famous major worldwide SEM/TEM makers
6. Highest quality & Lowest price
Porous Membrane

<Isotropic>

<10nano size>

<Anisotropic>

<50nano size>
Microneedle Patch Template
Laser Micromachining
3D Ultra-Precision Laser Glass Process

<3 Nested Nozzle with 3D Channels>
3D Ultra-Precision Laser Glass Process

<150mm Dia Vacuum Chuck with micro holes, internal channels and rear opening for pump connection>
1. No Chipping & taper
2. All transparent materials applied; Soda-Lime glass, Diamond, Quartz, Tempered glass, Sapphire
1. Laser bonding machine sales for Intelligent/Smart Implant glass encapsulation
2. Technical processing/development license business for glass encapsulation and implant design
3. Glass to Glass and Glass to Silicon bonding without any adhesives
Laser Glass Bonding (Chip)

- Lid glass
- Spacer glass
- Die and wire bonding
- Top side plating
- Through glass vias (TGV)
- Base glass
- Bottom side plating
- Ball grid array (BGA) interface
Laser Glass Hole Drilling for Dye Sensitized Solar Cell
Laser Glass Marking/Patterning (Hologram Effect)
Laser Micro-Hole Drilling

1. Applications; Pinholes, Apertures, Orifices, Slits, Shapes in a variety materials; Tungsten, Copper, Ceramic, Molybdenum, Stainless, Teflon, Glass, etc
2. A few micron size holes with various dimensions and arrays
3. Many sales records
Laser Micro Cutting/Drilling/Welding

<Laser Metal Microcutting>

<Laser Metal Welding>
Laser Poly Materials Cutting & Welding

<PET Cutting Sample>

<PET Welding Sample>
Laser Plastic Welding
<KLT Key Business>
1. Design & Development
2. Processing Technology Transferring
3. Systems Sales
4. Samples Fabrication Service
5. Proto & High Volume Production
<Contact Point>

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