地域クラスターセミナー　　平成16年6月25日

「熊本の半導体製造企業集積からQTATクラスターへ」

Kumamoto IT-production area toward the future on QTAT cluster.

熊本大学工学部／衝撃・極限環境研究センター 教授
熊本地域結集型共同研究事業 副研究統括 久保田 弘　Professor KUBOTA Hiroshi

頭 脳 拠 点 形 成

[共同研究開発]：**科学する.**
- 下請け意識の排除（同時に地方行政の改革）
- テーマのコピーの排除（同時に地方大学改革）
- 最先端テーマは矛盾解決テーマ（大手企業改革）
- 目に見えないものをイメージしその仮説を実証する.
- ビジネス創造=トリニティー型共同研究 熊本方式

[人材育成]：**ネットワークを作る.**
- 現場で基礎研究最先端テーマを発見.
- イメージし，仮説を立てる.
- 他の分野に触れて，総合的に解決する能力を向上

世界に選ばれる熊本地域

・技術革新の激しい新製造業に
QTAT生産拠点
として魅力があること.

選択される条件

R&Dから
R&Pへ
基礎研究（R）＆
プロダクション（P）

Silicon-Island KYUSHU toward the QTAT forest

KOREA

CHINA

熊本半導体・映像デバイス 人材育成講座

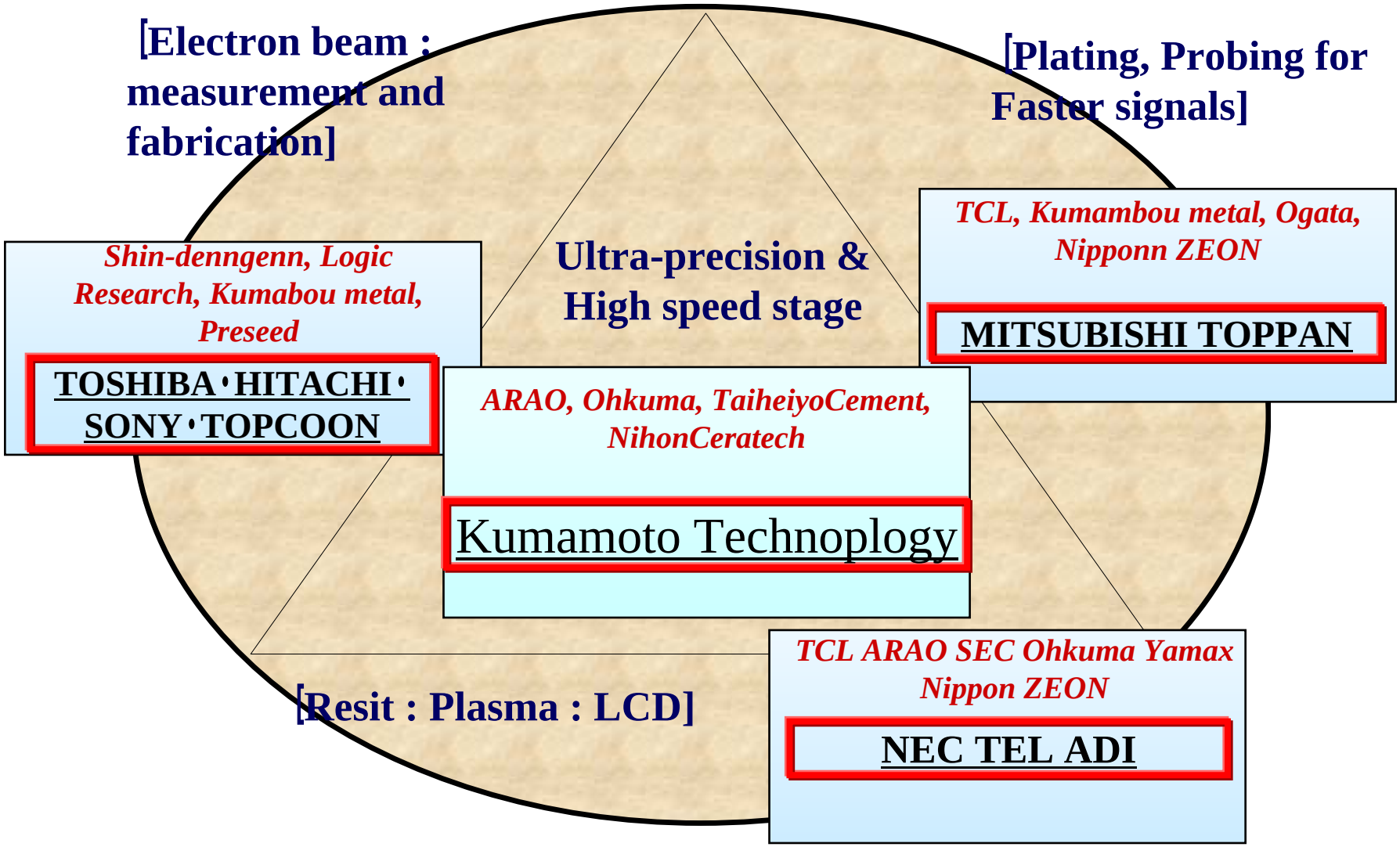
講 座 名 称	開催予定日	講 師 (平成15年度実績または予定)	備 考
《半導体初級講座》よくわかる半導体	5月14日	(社) 日本半導体製造装置協会(SEAJ)主催	【受講料】SEAJ会員：25,000円 会員外：30,000円
半導体入門	7月9日～8月7日	元 九州大学 助教授 森 紘	―
MOSデバイスシミュレーション	10月8日,15日,16日	熊本大学 大学院教授 久保田 弘／三菱電機㈱	―
LSIとその製造プロセス	7月3日,10日,17日	九州日本電気㈱	―
半導体組立・実装技術	12月3日,4日,17日	㈱ルネサス九州セミコンダクタ	―
メッキ・CMP技術	7月26日,27日,28日	㈱荏原製作所／㈱荏原九州	平成15年度新設
半導体計測・評価技術	11月12日,13日,26日	(財)くまもとテクノ産業財団／㈱トプコン	―
ディスプレイデバイス入門	10月1日,2日,15日	九州東海大学／東海大学 教授 鈴木八十二	―
液晶製造プロセス	1月14日,15日 2月 4日, 5日	熊本県立技術短期大学校/ソニー/ADI (注・1	―
CCD・イメージセンサー	12月10日,11日,24日	ソニーセミコンダクター九州㈱	平成15年度新設

■ 形 態 ： 集合研修＋課題＋講師のQ＆A（ [illegible] ）
■ 対 象 ： 中堅エンジニアおよび [illegible] 学生等
■ 開設講座： 9講座 [illegible] 名／講座）
■ 受講料 ： 18時間講座・・・ [illegible] 円（但し、県内 [illegible] 円）
36時間講座・・・ [illegible] 円（但し、県内 [illegible] 円）
■ 開催期間： 平成16年 [illegible] 月 ～ 平成17年 2月

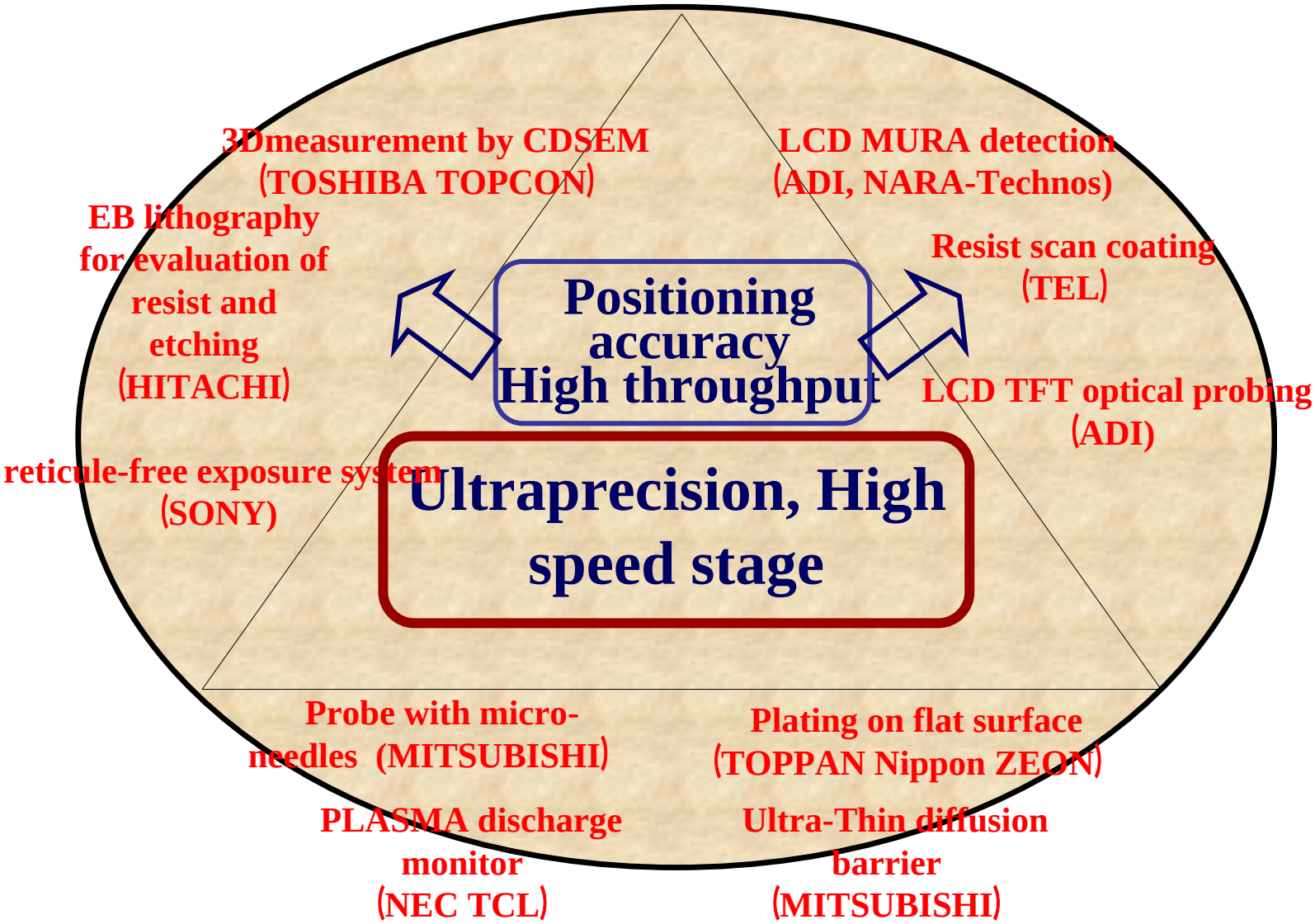
半導体・映像デバイス 年間10名の人材

トリニティー型 共同研究 熊本方式

Kumamoto free-project



Project formation



Creative subject should be in contradiction ！

- (ア) 位置･寸法精度をナノメーターレベルに保ちながら高速な移動を可能にするアクチュエータの開発
- (イ) 3次元計測を可能にする電子ビームティルティングを収差なく実現すること
- (ウ) 高周波対応の微細なプローブで電磁界結合のない構造と信号処理
- (エ) 正常なプラズマ装置でおきるはずのない異常放電の検出
- (オ) 矩形状試料へのスピンコーティング
- (カ) 高周波対応超平坦めっきにおける無粗化で密着性を向上させる技術開発
- (キ) 人の目に見えない輝度むら自動検査
- (ク) 超極薄膜による拡散防止性能の発現

Kumamoto Semiconductor Renaissance Micro- and Nano-fablication technologies by the cooperation among Industries, Universities and Government

Kumamoto Semiconductor Renaissance Micro- and Nano-fablication technologies by the cooperation among Industries, Universities and Government

Collaboration of Regional Entities for Advancement of Technological Excellence (MEXT,JST)

Regional consortium research and development project (METI)

—Activity for practical applications —

FY1999～2004

BIO department **AWARD** at 1st International NANO-Technology

—Create tech seeds —

Evaluation System for Sub-0.1 Micron Node

①Ultra high precision and high speed stage
Kumamoto Technology,Arao, Nihon Ceratec,Taiheiyo Cement

②3D-CD SEM（Beam tilting measurement technology）
Topcon,Shindengen Kumamoto,Toshiba

③Micro probe for high frequency circuit testing
Tokyo Cathode Lab.,Mitsubishi Electric

④Plasma discharge monitoring system by acoustic emission sensors
Tokyo Cathode lab.,NEC,NEC Kyusyu

⑤Scanning resist coater
Tokyo Erectron Kyusyu,Zeon

⑥Strong plating on flat resin
Toppan,Kumabo Metal,Ogata Kogyo,Zeon

⑦LCD uniformity(MURA) tester
Sakurai Enginiaring,Ookuma Denshi Yamax,ADI,Technos,Arao

⑧Reticle-free exposure system & thin film diffusion barrier
Preceed,Sony,Sony Semiconductor Kyusyu Technos,ADI,Logic Research

Penetrated seeds into industry

Kumamoto Univ., Tohoku Univ., Sojo Univ., Hiroshima Univ., Kumamoto IRI, AIST

FY2001
Nano-surgery
(Seed ①)
Kumamoto Tech. Arao, Transgenic Genetic Lab.

FY2002
Online direct patterning for QTAT
(Seed ⑧)
SONY, Tecnos, Kumamoto Tech., Preceed, USHIO

FY2002～FY2003
Hybrid 3D-CD-SEM with electorical measurement
(Seeds ①・②)
Topcon,Technodesign, Kumamoto Tech., Arao

FY2003
Plasma discharge reduction system
(Seed ④)
Tokyo Cathode, NEC Kyushu, NEC Electronics

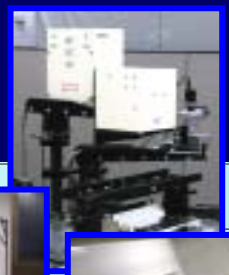
FY2002
Nano-probe for semiconductor testing
(Seed ①)
Kumamoto Tech., Arao

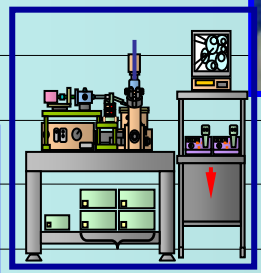
FY2002
Evaporate dryer for scan coating
(Seed ⑤)
Tokyo Electron Kyusyu Hayashi, Zeon Treasure of Tech.

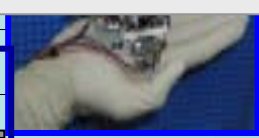
FY2002
High frequency PCB
(Seed ⑥)
Kumamoto Bosei, Ogata, Seibu, Toppan, Zeon, C.Uemura Sony Semiconductor Kyusyu

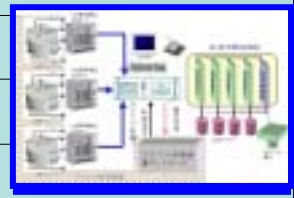
熊本フリープロジェクト商品群

オプション、なし本体価格 M ¥









浮上式リニアモーター方式

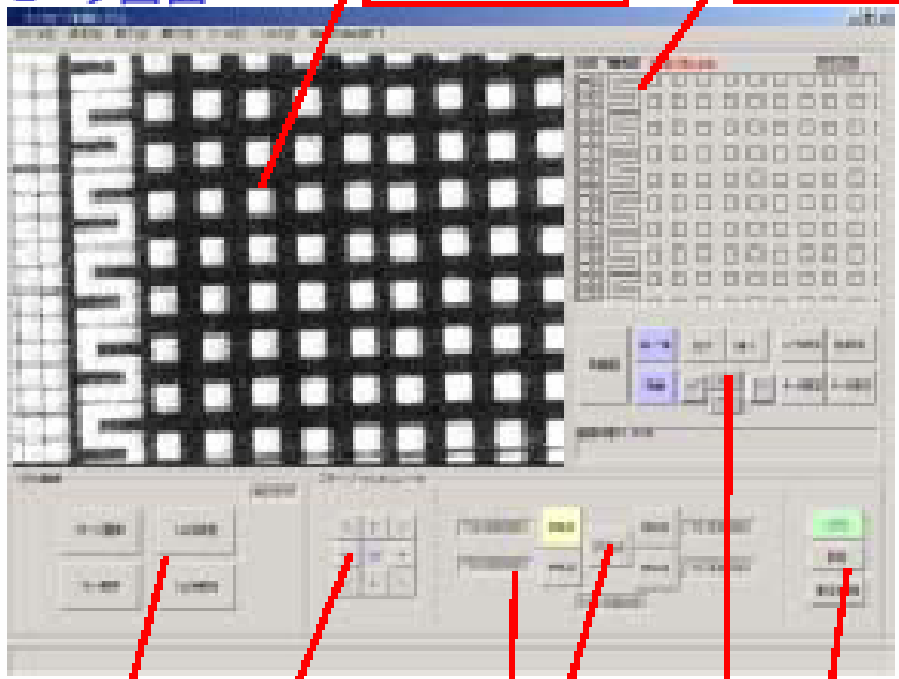
(N社, Y社 方式等) の破綻！

非接触は制定制御難と磁気シールドの重量過大. 接触式の磨耗問題とパーティクル発生を熊本テク 非共振方式で一挙に解決

マーケットと設計／製造プロセスを融合する技術
CAL（Computer Aided Lithography）

操作環境

モニタ画面



ステージ・マニピュレータ
JOG操作

主操作
パラメータ設定
JOG動作軸選択

SEM画像
表示，フィルタリング操作

ステージ・マニピュレータ
操作，位置情報

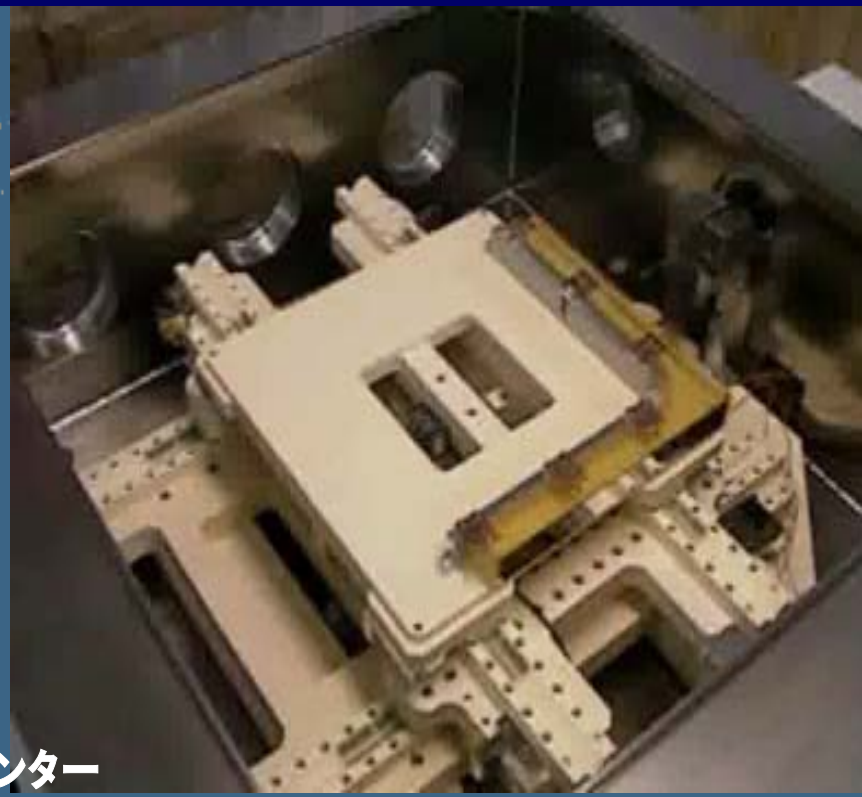
座標表示

JOG選択

CAD図の表示，フィルタリング
サーチ設定等操作

モーター操作選択

日本最北端から最南端へホールインワンする技術 ⇒ 広域連携・販路拡大



北海道大学

ジェネティックラボ

3000 km

東北大学

群馬大学

日本セラテック

次世代半導体研究センター

長岡技術大学

東芝 トプコン 日本電子 日立 ニコン Leepl キャノン

奈良テクノス

太平洋セメント

三菱電機

名古屋産業技術センター

ソニー

熊本大学

熊本テクノロジー

アラオ プレシード

東京エレクトロン

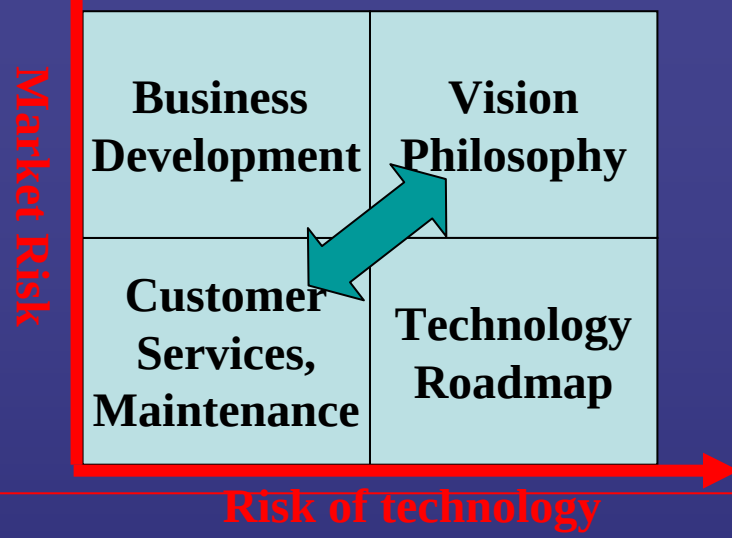
国立天文台

ハワイ島すばる天文台

3cmカップ

事業化に対するコメント

(2/23/04原田　裕介 氏講演コメント



地域クラスターに対する産業界からのコメント

A. マーケットそのものの開発やマーケットへのPenetration Strategyは何か？

B. 技術成果をマーケットに如何に活かして勝利するかという戦略的視点が欠けている？

熊本地域クラスターの現状

1. トリニティー型共同研究熊本方式

2. 設計CADの使用方法や設計プロセスの高度化に加えてマーケットのニーズをすぐに生産へ反映できる技術，すなわちQTAT技術にフォーカス．

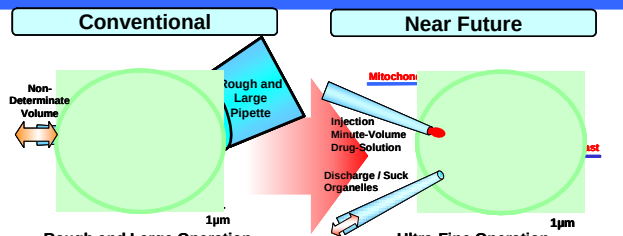
3. 技術成果をマーケットに如何に活かして勝利できるかは，その技術のビジョンすなわち哲学が問われている．

4. 新技術を生産現場に採用いただくときに，その不確定性をしのぐ超精密計測技術をセットでpenetrationすること．

5. 新技術エージェントが把握して商談を進めている件数：１４件，研究統括が動いている件数 9件，そのほかにも各社において多数対応中．

Nano-Surgery System
by Ultra-Precision Semiconductor Technology

From Micro-surgery, To Nano-surgery



Rough and Large Operation in Micrometer Range

- Artificial Insemination
- Patch Clamp Recording
- Injection of DNA

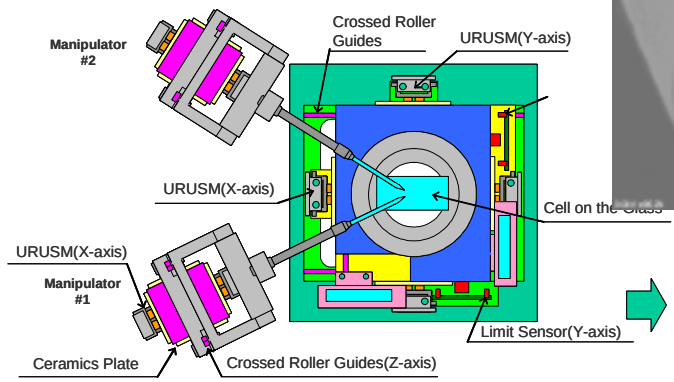
etc.

Ultra-Fine Operation in Nanometer Range

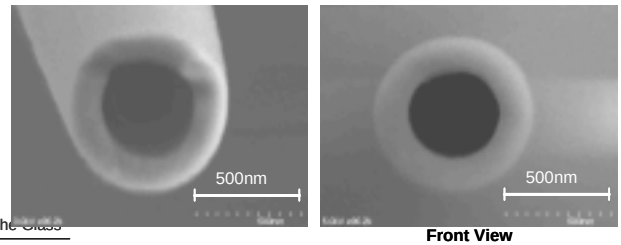
- Development of New Crossbreed
- Improvement of Mitochondria Disease
- Study on Cell Organelles

etc.

Stage / NanoManipulator



Tip of Nano-Pipette

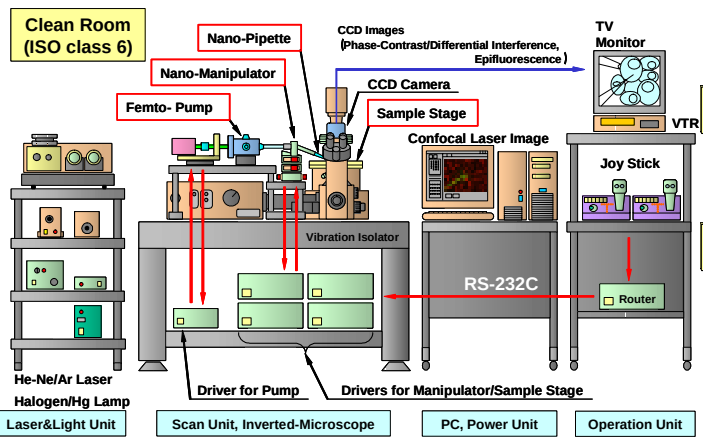


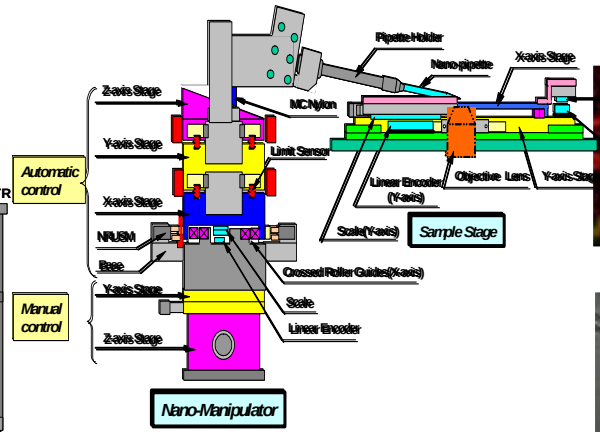
Front View

Internal diameter: ϕ420nm
External diameter: ϕ720nm

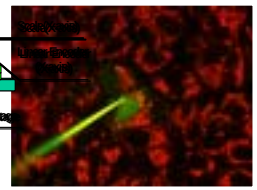
Nano-pipettes with internal diameter less than 1μm can be formed by this process.

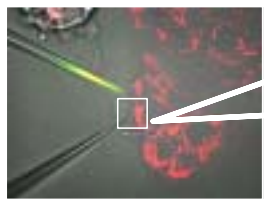
System Cofiguration





Cell Operation





本研究開発は、新エネルギー・産業技術総合開発機構の平成12年度即効型地域新生
コンソーシアム研究開発事業の委託により行われたものである。
管理法人：くまもとテクノ産業財団
参加機関：北海道大学、熊本大学、小樽商科大学、
(有) 熊本テクノロジー、(株) ジェネティックラボ、(株) トランスジェニック

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〒860-8555 熊本市黒髪2丁目39番1号
熊本大学大学院 自然科学研究科
TEL：096-342-3035 FAX：096-342-3065
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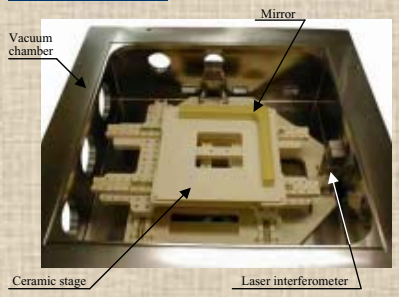
インキュベーションセンター A-2
TEL：096-287-1261 FAX：096-377-2278
kosaka_kouji@technologies.co.jp

Nonresonant type Ultrasonic Motor Driven High Speed Precision Stage

Kumamoto Technology Inc., Taiheiyo Cement Co., Nihon Ceratec Co., Ltd., Arao Co., Ookuma Electric Co., Ltd.,
Kumamoto Industrial Research Center, Nagaoka University of Technology, Kumamoto University, Tohoku University

Stage exterior



Stage specification

Actuator	Nonresonant type ultrasonic motor
Feed velocity	150 mm/s
Travel	300 mm
Positioning accuracy	±0.6 nm
Resolution	0.6 nm
Yaw/Roll/Pitch	± 1 sec.
Guide system	V-type roller guide
Measurement system	Laser interferometer
Stage material	Alumina ceramics (9.5%)
Dimensions	
Total system	1210 x 1310 x 1200 mm
Stage	800 x 800 x 250 mm
Chamber	1170 x 1170 x 400 mm

Stage feed performance

Resolution and servo tracking performance of the nonresonant type ultrasonic motor is evaluated by positioning property and constant velocity feeding properties of the stage*1.

Evaluation

1. Positioning property
   Step width 500 µm
   Relative positioning accuracy ±0.6 nm
   Retention time after positioned 100 ms

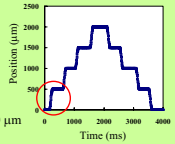
2. Constant velocity feeding property
   Feed velocity 100 nm/s, 20 mm/s

3. Maximum velocity feeding*2
   Open-loop control

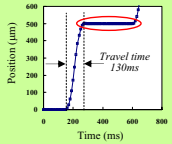
Results

Statically/dynamically high positioning accuracy is obtained by using the non-resonant type ultrasonic motor.

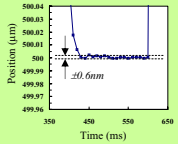
*1 atmosphere environment
*2 100 mm stroke stage



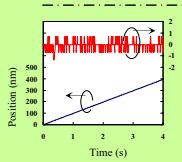
500 µm step & repeat response



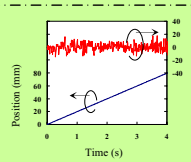
Enlarged view of step response



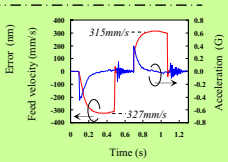
±0.6 nm positioning



100 nm/s constant velocity feeding



20 mm/s constant velocity feeding



Maximum feed velocity

Working scheme

FY 2001
Control resolution < 1 nm
Feed velocity 300 mm/s
Acceleration 0.1 G

FY 2002
Evaluations in CD-SEM, EB-system applications.

FY 2003
Practical application

Kumamoto Technology

Kumamoto Technology Inc.
Tel :+81-96-287-1260, E-mail :kosaka_kouji@technologies.co.jp

Reticle-Free Exposure Technology

～ Ultimate Mix & Match ～

Features

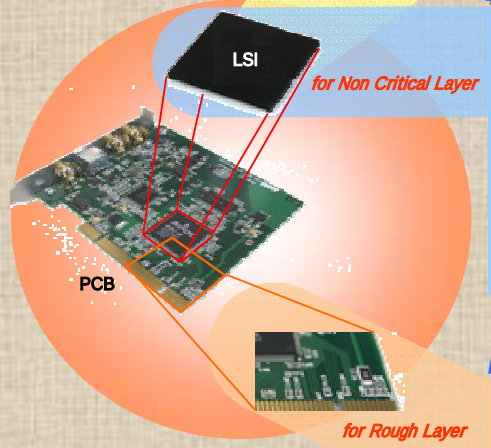
- No need Photomask
- CAD Data Common

MIX&MATCH

Miniaturization, Low Cost, QTAT

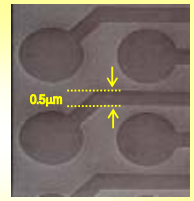
New Exposure Technology for High-mix Low-volume Production

Mix and Match



EB Exposure System


EB Exposure system (HL-700)

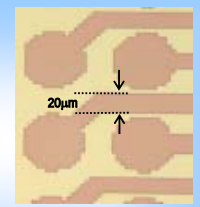


EB Exposure Pattern

Possible to fabricate submicron arbitrary pattern using EB exposure system
(Application) Gate, Contact hall etc

Stepper


g-line Stepper (NSR1505G3A)

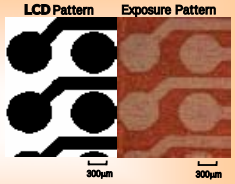


Stepper Exposure Pattern

Possible to fabricate several micron arbitrary pattern using stepper & LCD reticle
(Application) Metal Layer for LSI, MEMS etc

Reticle-Free Drect Exposure System


Reticle-Free Proximity Exposure System



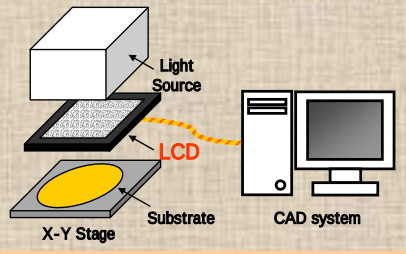
Possible to fabricate hundred of microns arbitrary pattern using proximity exposure system & LCD mask
(Application) PCB Wiring Layer, Bump Fabrication etc

Kumamoto University
Kumamoto Technology
Kumamoto Technology Incorporated
SONY
Sony Semiconductor Kyushu Corporation
TECNOS Company limited
USHIO
USHIO Incorporated
PRECEED
PRECEED Company limited

Online-direct patterning for QTAT

～Arbitrary Pattern Exposure System without Mask～

Reticle-Free Exposure Method



Features

- Mask is replaced by LCD panel
  ⇒ No need Photomask
- Modification of Pattern is very easy
  ⇒ CAD data modification

Low Cost & QTAT Lithography Process

Application

☆ Pattern Fabrication for PCB

Metal Layer for PCB

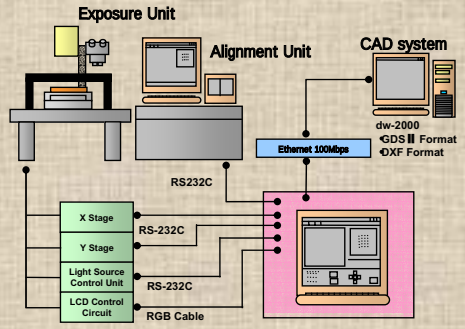
Others,
for Si wafer,
for SiP (System in Packege)
etc

Exposure Unit Spec

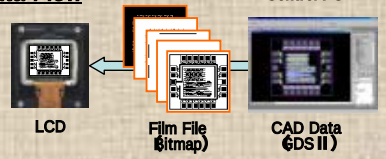
Light Source	g-line (436nm) and h-line (405nm)
Exposure Region	125mm□
Minimum Line Width	50μm
Stage Architecture	X-Y 2axis using NRUSM (Non-Resonance type Ultra-Sonic Motor)
Alignment Accuracy	±1μm

System Configuration

System Architecture

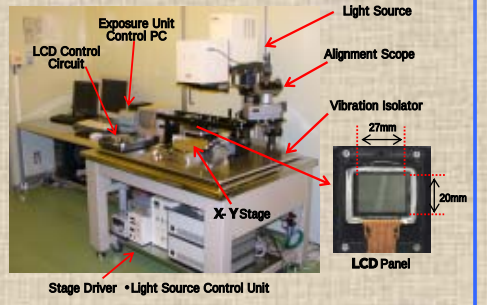


Data Flow



Exposure pattern generated by CAD is transferred to LCD

External View of Exposure System



Kumamoto University Kumamoto University
SONY Sony Semiconductor Kyushu Corporation
USHIO USHIO Incorporated
Kumamoto Technology Kumamoto Technology Incorporated
PRECEED PRECEED Company limited
TECNOS Company limited

Film-Thickness Uniformity Inspection

Tecnos Co., Ltd. Kumamoto University ARAO Kumamoto Applied Electronics Research Center

Feature 1 **Large area panels.**
Feature 2 **2D high speed inspection for Film Thickness distribution.**
Feature 3 **Transparent thin film on glass and metal substrates.**

Technical element

Acquisition technology of a continuously angled view with a sensor camera

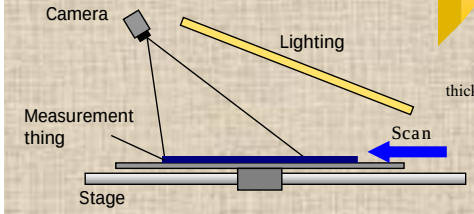
Film Thickness measurement technology from a continuously angled view

Application
Film Thickness MURA of a large-sized glass substrate is inspected on a macro target for a short time.

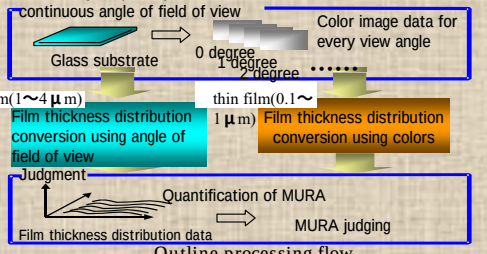
Target
Film Thickness MURA, other film MURA

Throughput
About 60 seconds
(1m angle grade)

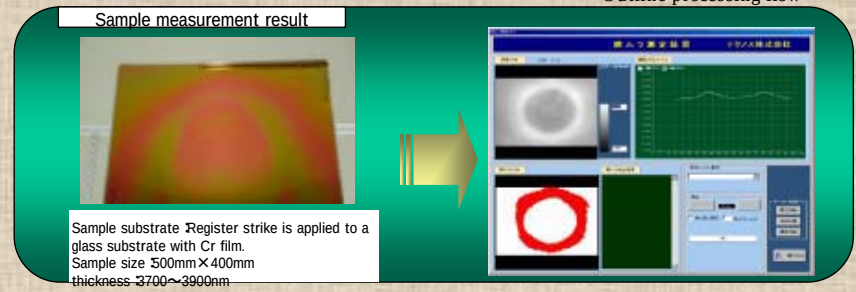
The example of equipment appearance



Basic composition image



Outline processing flow



Sample substrate：Register strike is applied to a glass substrate with Cr film.
Sample size：500mm×400mm
thickness：3700～3900nm

Reference

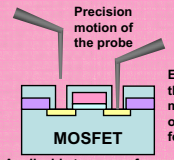
197-1 HOUREN-CHO NARA
630-8113 JAPAN
Phone：+81-742-36-3051
Fax ：+81-742-36-3052
E-mail：info@tecnos-net.co.jp
URL：http://www.tecnos-net.co.jp
TECNOS CO.,Ltd

Nano-probe for Semiconductor Testing

High-accuracy (positioning accuracy, 10 nm) and Long stroke (X and Y, 20 mm) small size nano-manipulator installed in a scanning electron microscope (SEM)!

Applications

☆ **Micro area probing for MOSFET, etc.**



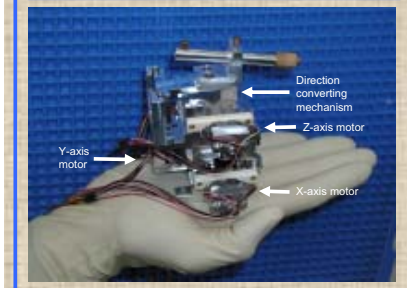
Electrical characteristics of the device immediately after manufacturing can be observed and immediately feed back to the process.

Applicable to areas of measurement and operations in nanometer level, such as;

- Electrical measurement and defect modification in micro area for various devices
- Measurement of physical properties of various nano materials
- Direct micro machining (MEMS, mounting, etc.)

And others.

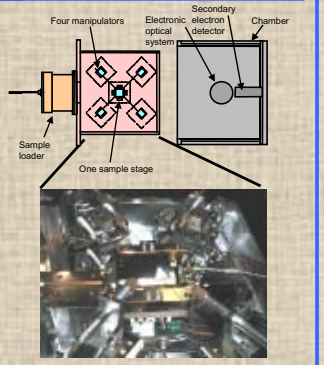
Exterior Appearance of the Manipulator

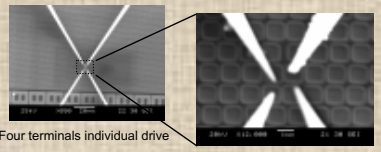


Specification of the Manipulator

Configuration of axes:	3 axes, X, Y, and Z
Stroke:	X and Y 20 mm (+/-10 mm)
	Z 5 mm (+/-2.5 mm)
Control resolution:	X and Y 10 nm (Z 2 nm)
Driver:	Non-resonant type ultrasonic motor
Position detection:	Linear encoder (Minimum resolution 10 nm)
Size:	65 x 65 x 77 mm
Weight:	1.5 kg

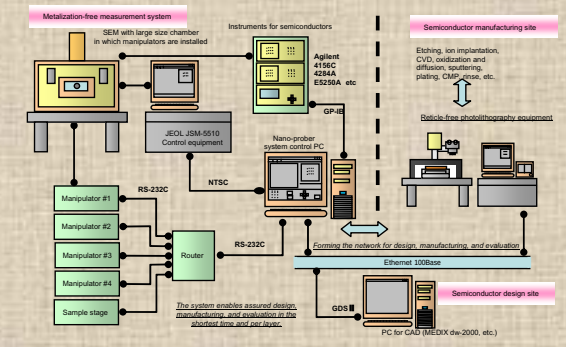
Installation in the SEM





Four terminals individual drive

System Configuration



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* This system has been jointly developed by Kumamoto University, Kumamoto Technology, and ARAO with Kumamoto Technology and Industry Foundation as the managing corporate body on consignment of *Research and Development Program for Quick Acting District Renewal Consortium" in 2001 FY of the Ministry of Economy, Trade, and Industry of Japan.

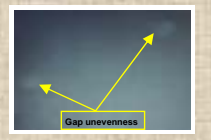
Hybrid Uniformity Inspection on LCD

Kumamoto Univ., Electron-applied Machine Technology Institute of Kumamoto Techno Industrial Foundation, Advanced Display, Arao, Technos

The unevenness inspection on LCD in the LCD panel inspection process requires observations at different angles.

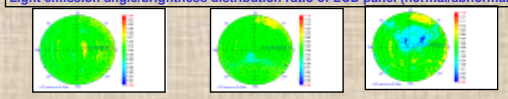
High-efficiency imaging acquisition system is indispensable.

Characteristic of unevenness (gap unevenness)

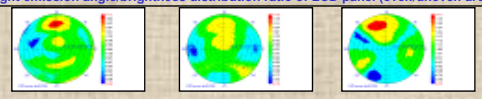


- Cause for gap unevenness
  ①Flexed glass board
  ②Change in density due to crowded or displaced spacers

Light emission angle/brightness distribution ratio of LCD panel (normal/abnormal areas)



Light emission angle/brightness distribution ratio of LCD panel (even/uneven areas)

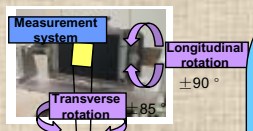


White color display | Gray color display | Black color display

Measurement: EZContrast180D

Unevenness is emphasized in the direction of upper side 50 ° on the panel with gap unevenness appeared.

Unevenness analysis by visual imaging



A 10-bit monochromatic camera measures 8×8 cm areas.

CCD camera

Calculation of visual-dependency

Light-concentration function g (θ) allows correct visual dependency to be acquired.

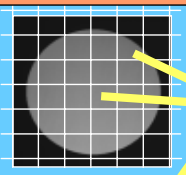
r (θ): Measurement data, g(θ): Correct LCD visual dependency

$$r(\theta) = g(\theta) * L(\theta)$$

$$F[r(\theta)] = F[g(\theta)] \cdot F[L(\theta)]$$

$$g(\theta) = F^{-1}[F[r(\theta)] / F[L(\theta)]]$$

*: Convolution integral F: Fourier Transformation
F-1: Inverse Fourier Transformation



Front view image

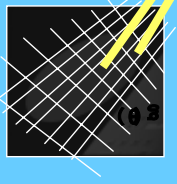
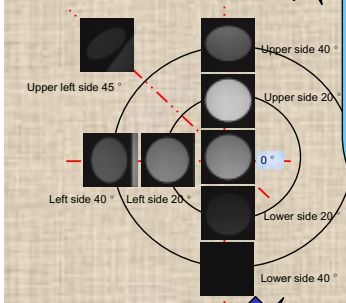


Image taken from the position at upper left 45 °

3D display of brightness distribution (Vertical display)

Acquired data



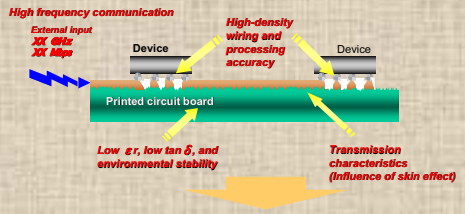
Detected unevenness in multi-angle images

Visual-dependency and position-dependency are used for analyzing hybrid-unevenness.

High Frequency PCB for SiP

Innovative technology using materials with less environmental change and new plating process

Needs for high frequency print circuit boards



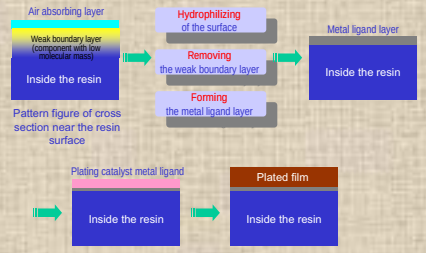
Wiring needs to be formed on the smooth resin surface using materials with less environmental change and excellent isolation characteristics.

Material being studied

Property		Value	Test Method
Electric properties (GHz)	Specific inductive capacity (εr)	2.7	JIS C6481 (65℃、90%RH、168H r)
	Dielectric dissipation factor (tan δ)	0.009	JIS C6481 (65℃、90%RH、168H r)
Water absorption		0.14%	JIS K7209
Isolation characteristics	Initial value	10^{14}	135℃、85%RH、DC5.5V L/S=75μm、300Hr
	After testing	10^{13}	

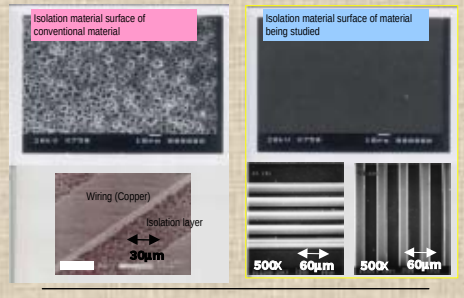
Isolation material with lower specific inductive capacity, dielectric dissipation factor, and water absorption, and excellent stability and isolation performance in the environment

Plate Film Forming Technology on Smooth Surface

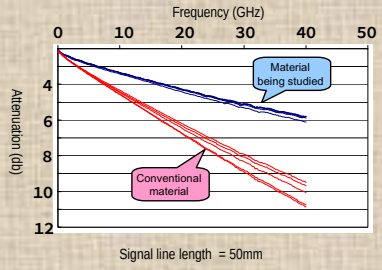


Adhesion strength practically required, approximately 593 gf/cm is achieved.

Wire forming accuracy



Electric Properties (S21 parameter)



Signal attenuation is down to half of conventional material.

Plating Line for Development of High frequency Print Circuit Board

1. Scale up
   - Boards with practical work size, 340x340 mm, can be experimentally manufactured.
2. Applicable to micro wiring (fine pattern) forming
   - Applicable to panel plating process for utilizing smoothness of resin surface
   - Filtered circulation equipment in stalled in all processing tanks

Expansion for actual work size
Establishing reliability using practical boards

This research is being performed in "Regional Consortium Research and Development Project " in 2001 FY of the Ministry of Economy, Trade, and Industry of Japan.

Managing corporate body: Kumamoto Technology and Industry Foundation

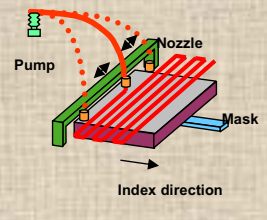
Participants: Uemura Co.,Ltd, Ogata Co.,Ltd, Kumamoto Bosei Kougyou Corp., Seibu Co.,Ltd, Sony Semiconductor Kyushu Corp., Toppan Printing Co.,Ltd, ZEON Corp., Kumamoto University, and Kumamoto Technology and Industry Foundation

Scanning resist coater

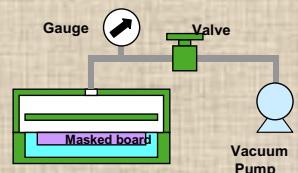
Tokyo Electron Kyushu, Zeon, Hayashi, Treasure of Technology, Kumamoto Industrial Technology Institute, Kumamoto Technology and Industry Foundation, Kumamoto Univ., Tokyo Univ., Tohoku Univ.

Outline of scan-type film Coating equipment

Scan coating



Vacuum drying



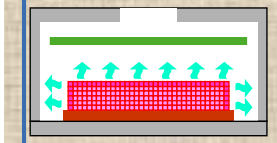
Appearance of equipment

Clean room, Kumamoto Techno Industrial Foundation

Vacuum drying simulation

The program is prepared to elucidate the mechanism, which is useful in developing high-performance equipment and simulator.

Vacuum drying equipment

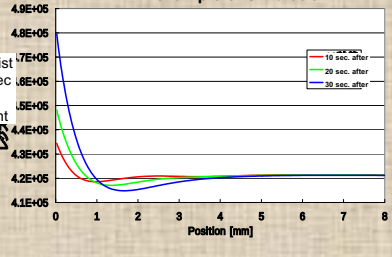


Diffusion phenomenon focused

Computation algorithm

- Solvent evaporates at surface cells
- Solvent concentration is made higher
- Solvent molecules move
- Resist molecules move

An example of simulation



As drying proceeds, the board edges rise. From the result from the analysis, the method, by which uniform films are formed by vacuum drying, are calculated.

Appearance of the board

Mask plate by high-precision vacuum drying equipment

Example of application

Simulation analysis of the vacuum drying process

➔ **Analysis can be made independently of the type and shape of boards, and the type of solutions.**
The film thickness profile can be uniform.
The processing time can be simulated.

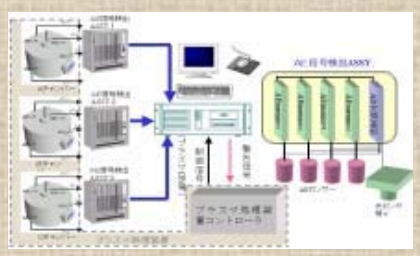
Application
- **Coating process of masked plates**
- **Drying process of semiconductor fabrication**

Acoustic Plasma discharge Monitor (APM)

Tokyo Cathode, NEC Kyushu, NEC Evaluated Technology Development Head Office, Electron-applied Mechanical Technology Institute of Kumamoto Techno Industrial Foundation, Kumamoto Industrial technology Center, Kumamoto Univ., Tohoku Univ.

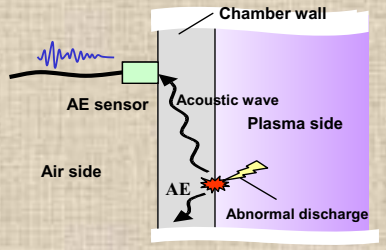
The Acoustic Plasma Discharge Monitor is developed based on a new concept detecting abnormal plasma discharge generated during semiconductor-preprocess plasma equipment using the AE (Acoustic Emission) method.

Appearance of APM



Configuration of APM

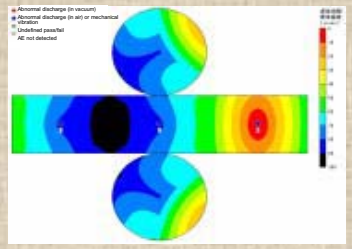
- Detects abnormal plasma discharge generating within plasma equipment at a high sensitivity in real time.
- Can be easily installed on any type of equipment because the sensor is attached on the outer wall of plasma equipment
- A multi-point sensor pinpoints the locations, at which abnormal discharge has happened, correctly.



Principle of abnormal discharge detection

Attaching the sensor

Example display of abnormal discharge frequencies



Example display of abnormal discharge points

Contact: Tokyo Cathode Institute TEL096-279-3535 e-mail :m.yasaka@tclab.co.jp

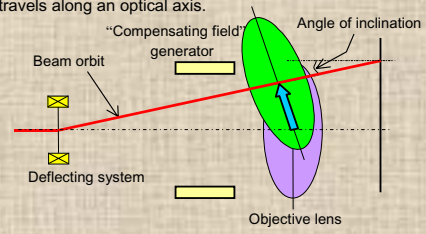
3D-CDSEM

Edge-measuring SEM enables 3D geometry analysis of wafer

Appearance

Acquiring inclined lines

To acquire higher-resolution inclined lines, objective lens is electrically moved or declined in the "compensating field" so that a beam deflected by the deflecting system travels along an optical axis.



Features

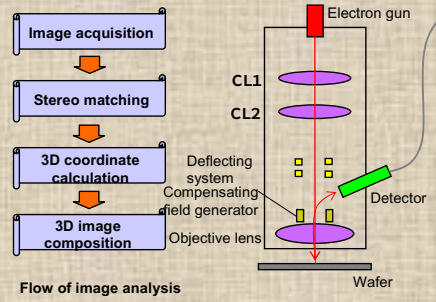
- Maximum tilting angle ±10°
- Spatial resolution 1.5nm
- Observed gradient resolution 2nm (10°)
- Measuring range 0.05~15μm
- Depth of focus 1μm
- 3D measurement accuracy 4nm
- Measurement time 10sec./site

Application

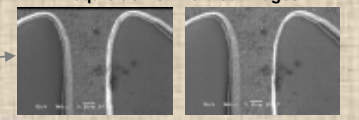
- **Control of cross-sectional geometries such as wafer patterns**
  Measures the dimensions of cross-sectional geometries and provides feedback data, which in turn, is reflected in the information on exposure conditions.
- **Control of side geometries such as irregularity and unevenness**
  Monitors and measures 3D patterns for any defective.
- **Control of pattern edge roughness**
  Prevents electrical properties from deteriorating due to edge roughness.

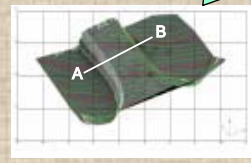
Proved example

3D geometries of wafer patterns can be measured by taking declined images of them using an end-measuring SEM and making image analysis.

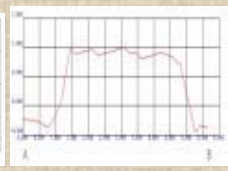


Flow of image analysis





3D image composition



A-B cross-sectional profile

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Regulating authority: Kumamoto Techno Industrial Foundation
Joint development organization: Toshiba