Core module design and control technology for multi-wafer inspection equipment

Design and Control Technology of Wafer Inspection System with Multi Probing

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Patent title Multi-probe system

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Authority status Registered

Technicality

Technology overview

Multi-probing inspection equipment is core equipment which inspects the defects of chips on which all wafer patterns are made in a semiconductor production process. The technology is a design and control technology of core modules of inspection equipment (a cartridge, an aligner, a transfer robot, a multi-chamber, a high-precision tilting module, a low-noise chuck, a ceramic piezoelectric element, or the like) in which during semiconductor wafer probing (measurement) and burn-in test (inspection), 10-25 wafers are simultaneously inspected by one prober, and thus the time consumed is shortened.

Development background and problem to be solved

- To provide an electrical signal and a probe station including a probe card having a plurality of probes, a semiconductor element inspection process is performed by a tester connected to a probe card. A single probe device, which is a conventional substrate inspection device, can inspect only one substrate at a time.
- Thus, inspection takes a long time, and this causes limits on the total production time. Therefore, there is a need for a technology of improving the efficiency of an inspection process by inspecting multiple substrates at the same time.

Excellence and discrimination of technology

▶ Excellence of technology

- An inspection process time is shortened by inspecting multiple substrates at the same time.
- Production costs of using one multi-probe system instead of multiple single-probe devices are reduced.
- Unlike an existing vacuum coupling method, a mechanical coupling method is used when a substrate inspection cartridge is produced.
- Through the mechanical coupling of a coupling member of a substrate inspection cartridge, a substrate, a chuck member, and a probe card are strongly coupled.
- Due to a locking structure of a body part and a probe card structure body of a chuck assembly, coupling and separation are easy.

▶ Discrimination of technology

- Multi-channelization is achieved so that multiple (average 10 to 25) integrated semiconductor prober functions are achieved in one multi-type semiconductor prober.
- Production capacity and space efficiency are improved by increasing simultaneous inspection wafer throughput.
- A defective rate is reduced due to improved contact precision, and damage to expensive components is prevented.
- An inspection failure rate is reduced and technological competitiveness is strengthened by enhancing a low noise coefficient.

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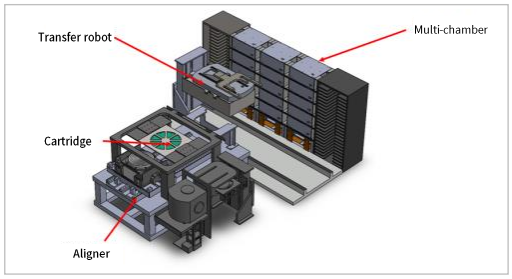
Implementation method

According to the present invention,

- Included are a supply unit, an aligner unit, a standby unit, an inspection unit, a transfer unit, and a control unit.
- A multi-probe system simultaneously inspects multiple substrates after a substrate preprocessing process is completed.
- In an aligner unit, an inspection cartridge is stacked and coupled by sequentially coupling a chuck, a substrate, and a probe card, and the inspection cartridge is moved to the inspection unit to perform a substrate inspection process.



Picture 1 High-speed multi-probing wafer inspection system schematic diagram and cartridge

Picture 2 Aligner prototype

Degree of technology completion (TRL)

Degree of technology completion: TRL5 (Achievement environment application experiment stage)

TRL1	TRL2	TRL3	TRL4	TRL5	TRL6	TRL7	TRL8	TRL9
Technical principle presentation	Technology concept setting	Technology concept verification	**Lab Scale prototype development**	Implementation environment application experiment	Full Scale prototype development	Quasi-commercial product development	Commercial product development	Commercial product implementation

Utilization

Utilization field and applied product

Utilization field

- Semiconductor equipment
- Precision stage
- Transportation device
- Medical device

Picture 1 Wafer prober

Applied product

- Wafer prober
- Precision aligner equipment
- Test equipment
- Mobile phone vibrator

Picture 2 Test equipment

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Technology trend

- The market is shifting from semiconductor-based finished products represented by PC and IT servers to mobile devices such as small smartphones based on low power consumption. Thus, for mobile products, it has become essential to solve the problems related to low power consumption and heat generation so as to reduce the sizes of components. Accordingly, the degree of integration of semiconductor components is improved, and fine patterning and lamination technologies, TSV technologies, and the like are being developed.
- Furthermore, as the degree of integration of a semiconductor increases and an operating clock increases, commercialization of a wafer level packaging technology beyond the traditional packaging structure has begun. Thus, the number of probe needles in a probe increases, and the size of the probe is also reduced. Accordingly, inspection equipment corresponding thereto is being developed.
- The structure of semiconductor components is changing from a two-dimensional element to a three-dimensional element, and thus post-process inspections are also becoming increasingly complex.
- Semiconductor inspection equipment is mostly dominated by a small number of global companies. Most domestic companies are concentrated on the fields with low technical barriers, such as probe cards and handlers, and some fields such as memory test equipment and optical inspection equipment for FPD have entered the global market.

Family patent status

Application nation	Application No. (Application date) / Registration No.	Title of the invention
KOR	KR 10-2017-0153155(2017.11.16) / 10-2049413(2019.11.21)	Multi-probe system
KOR	KR 10-2017-0126318(2017.09.28) / 10-2014334(2019.08.20)	Substrate inspection cartridge and method for producing same
KOR	KR 10-2018-0149659(2018.11.28) / 10-2164132(2020.10.05)	Chuck assembly and channel for multi-prover
KOR	KR 10-2020-0151843(2020.11.13)	Crystal-oriented piezoelectric ceramics production method, method for improving piezoelectric properties of crystal-oriented piezoelectric ceramics, and piezoelectric ceramics with improved piezoelectric properties

Market prospect

Target market size and prospect

The global semiconductor inspection equipment market size is expected to grow at a CAGR of 3.05% from USD 393.9 million in 2013 to USD 3.3 billion in 2021, and the amount of the investment in semiconductor facilities is expected to be the highest in history. In particular, the facility investment of Samsung Electronics and SK Hynix in Korea is expected to increase sharply thanks to an increase in memory demands and the competitive edge in microprocessing.

(Unit :million dollars, %)

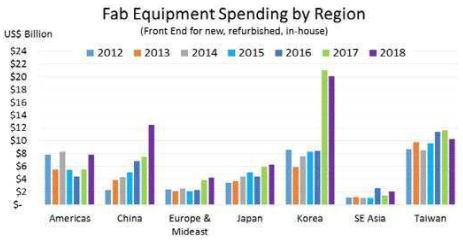
Division	'16	'17	'18	'19	'20	'21	CAGR
Global market	2,897	2,966	3,057	3,148	3,243	3,340	3.05

(Unit :0.1 billion won, %)

Division	'16	'17	'18	'19	'20	'21	CAGR
Domestic market	215	223	231	238	247	255	3.45

Table **Semiconductor inspection equipment market size**

<Data: SME Technology Roadmap (2018-2020)_Intelligent Sensor >



Picture **Trend and forecast of semiconductor equipment investment amount by region**

<Data: International Semiconductor Equipment and Materials Association>

Technology transfer query

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Technology transfer process

Explore promising technologies → Contract consultation → Apply for technology transfer → Negotiate and sign contracts → Follow-up support