Theme: Semiconductor Equipment

- Sub Theme: Fundamental Automation&Manipulation Technology for Semiconductor Equipment

① High Precision Wafer Cleave & Polishing

One of the widely used methods for observing the internal structure of the semiconductor wafer is to make a vertical section of the wafer and observe it with SEM (Vertical SEM). Because the physical properties of the wafers vary depending on the target product and process state, specimen preparation is difficult to automate.

The main goal of this GRO project is to develop core technology for preparing target specimens for Vertical SEM automatically, especially for high precision cleaving, and high precision polishing.

For this, we first need the technology to design and control the actuator system integrated with the vision camera, to control specimen and tool for micrometer-scale target accuracy.

In cleaving, the path of crack is not always predictable, and the section made from cleavage is not always perfect. We hope to get a better understanding of the cleavage, and the way to control it through this GRO. For this, we may need high bandwidth force control, to stabilize force during cleavage.

In polishing, we need to find a methodology to make the smooth vertical plane, on a 100-nanometer scale, with various materials mounted on the wafer. Also, because the thickness of the wafer is less than a millimeter, achieving verticality of the cross-section becomes challenging.

② Robot Technologies for Flexible Object Handling

With the recent rapid growth of robot technology, attempts are being made to handle various types of objects using robot manipulators. Most automation systems and robots have only handled rigid objects, and the handling of flexible/deformable objects has been considered to belong to manual works. Many flexible/deformable components are also used in the semiconductor industry, and robots must be able to handle these to achieve a complete unmanned factory.

In order to handle the flexible/deformable object with a robot, the object must first be recognized through the vision system, and its shape should be reconstructed in real-time to provide morphological and dynamic information about the object for the robot control. Then, with this information, a customized gripper grips the object without any damage, and a manipulator(s) controls the shape and positions/installs it to where it should be.

To do this, we would like to develop the following core technologies related to flexible/deformable object handling through this GRO.

- Real-time flexible body recognition and reconstruction
- Robot gripper that handles flexible/deformable objects avoiding any damage.
- Robot Manipulation that transforms flexible/deformable objects into any desired shape and move/install it to the desired position.

③ Robot Manipulator Design

With the development of robot technology, more and more tasks are being automated, and manual works in semiconductor fabs are also actively automated. In particular, there are many replacement tasks for heavy components in equipment maintenance. However, these tasks are frequently complained about by the workers not by only their weight but also by the small/narrow workspace inside of the equipment. For these reasons, the demand for automation in dealing with heavyweight is increasing rapidly.

However, few commercial robot manipulators can handle such heavy objects in such narrow spaces. In most cases, the larger payload, the larger volume of the manipulator. In addition, a sufficient degree of freedom is required to work without collision with facilities in a cramped space, but most of these features lower the payload of the manipulator and increase its volume.

Therefore, we are highly interested in (but not limited to) the following list of topics.

- High-payload(>45kg) Manipulator Design
  . Low-Backlash High-Reduction Ratio Harmonic Drive
  . Clean room class hydraulic Manipulator
- Low inertia Manipulator Design
  . Cable-Driven Mechanism
  . Cell/Lattice Structure Design & Analysis

. Metal 3D Printing

- Redundant Manipulator Design & Control
  . Hyper-redundant manipulator
  . Redundancy Resolution

※ The topics are not limited to the above examples and the participants are encouraged to propose the original idea.

※ Funding: Up to USD 150,000 per year