R&D CMP SOLUTION

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Abstract

Chemical mechanical polishing (CMP) has been adopted in processing semiconductors for more than ten years. Although some customers expressed negative opinion about CMP at the beginning of its appearance, CMP has currently been applied to a variety of fields in addition to semiconductor multi-layer wiring strategies. This report summarizes each sort of CMP skills in their development stage and introduces each type of MAT ` s machines optimized for CMP research and development

1. Introduction

Chemical mechanical polishing (CMP) has been adopted in processing semiconductors for more than ten years. Although some customers expressed negative opinion about CMP at the beginning of its appearance, CMP has currently been applied to a variety of fields in addition to semiconductor multi-layer wiring strategies. This report summarizes each sort of CMP skills in their development stage and introduces each type of MAT's machines optimized for CMP research and development.

2. CMP applied on a diversified basis

While traditional CMP referred to the method for flattening the multi-layer wiring on semiconductors, CMP has recently been applied not only to semiconductors but also to various sectors as its processing reliability improves. This is backed by a variety of presentations given at the "Planarization and CMP Technical Committee" (abbreviated as the Planarization CMP Committee), a subcommittee of the Precision Engineering Association in Japan, and indicating that flattening may safely be replaced with CMP in general.

MAT delivers each kind of CMP equipment and scrub cleaning machines intended for such a variety of new processing applications.

Among them, the following section describes the characteristic products as follow:

1) CMP for flat panel displays (FPD)
2) CMP on chemical compound substrates
3) CMP for micro electro mechanical systems (MEMS)
4) CMP on thin-film magnetic heads

1) CMP for FPD

(1) CMP for liquid crystal display (LCD) color filters (CF)

CMP has primarily been adopted in order to improve efficiency in removing defective protrusions on the CF.

Figure 1 shows its typical structure, CMP purposes, and CMP parts.

As described here, three noticeable purposes of CMP on the CF are named.

First, the first one is to flatten (or improve surface roughness on) the CF protection film such as over-coating (O/C).

The second one is to remove defective protrusions such as residual resist or foreign material on the CF and O/C.

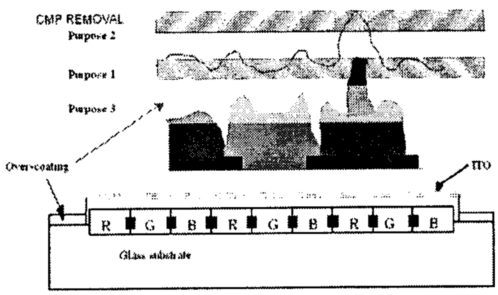
The last purpose is to eliminate steps on the C/F for cost reduction in such a manner that no O/C is to be used. In comparison with the two processes said above, it is difficult to achieve even flattening because of the difference of hardness among red, green, and blue.

In addition, while a variety of strategies and processes are upgraded so as to improve indication response and contrast, concern about flatness is encountered when a structure is to be installed on the CF.

CMP is thereby applied on the CF to be able to flatten the surface.

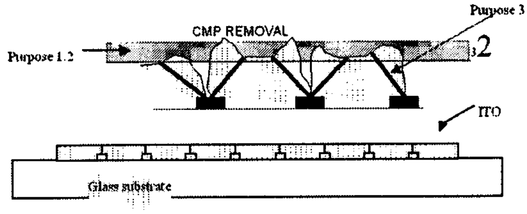
For high-speed, wide-perimeter panels to be released in the future, CMP will become an extremely important processing strategy.

Furthermore, MAT is one of the few manufacturers totally providing not only machines, polishing materials, pads, and fixtures oriented for FPD and CMP but also processing skills required by the user.



(2) Flattening an organic electro-luminescence display (OELD)

To improve the yield ratio, CMP has been adopted in this area as well. Figure 2 shows the structure and purposes. Purposes 1 and 2 are to improve surface roughness and remove defective protrusions on the ITO of the transparent electrodes and Purpose 3 is to control the cross sectional profile of the ITO covering.



2) CMP on chemical compound semiconductors

To mainly achieve quicker response than the traditional silicon substrates, the chemical compound semiconductors such as GaAs are used for the substrates. In recent years, CMP is also used for flattening the wiring on them.

In this case, the procedure is almost the same as typical CMP, except that the substrate could readily crack.

In addition, CMP is applied for each chemical compound in some processes for display devices using more than one chemical compounds. In this case, special processing strategies such as using slurry, load control, and endpoint control are significant.

3) CMP for MEMS

While MEMS are extensively understood in general, this section describes an instance where CMP is used for wiring such as RF-MEMS devices, including the findings (*1).

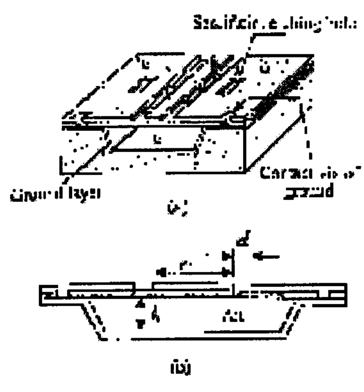


Fig. 1 Schematic view of the [illegible] (a) and the parameters of characteristic impedance (b)

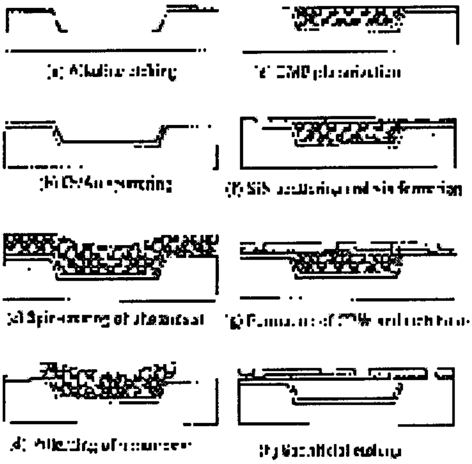


Fig. 2 Process Flow of the GCPW

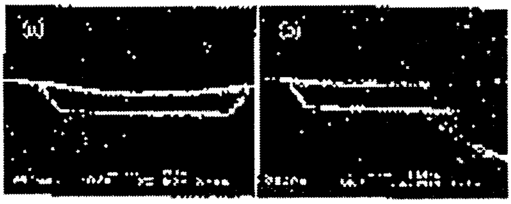
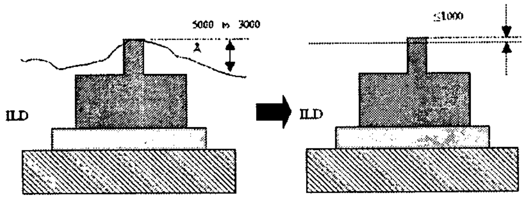


Fig. 3 Cross sections of the concave ... caused by the dishing attack during CMP (a) and the flat ... (b)

4) CMP on thin-film magnetic heads

On a thin-film magnetic head, there are at least 40 layers on the structure and further flatness is required as the material has recently been densified. This process is intended to flatten the metal (Permalloy or Ne-Fe in most cases) used as the magnetic material and the insulator covering. For each layer, several kinds of CMP in different processing is conducted. Figure 3 shows the typical structure and purposes.

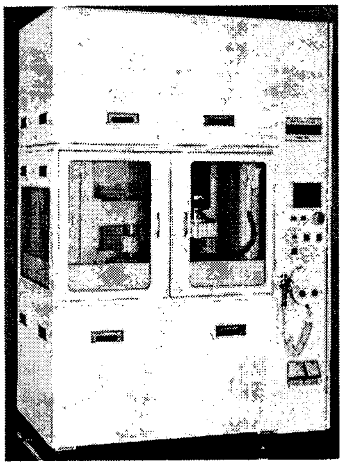


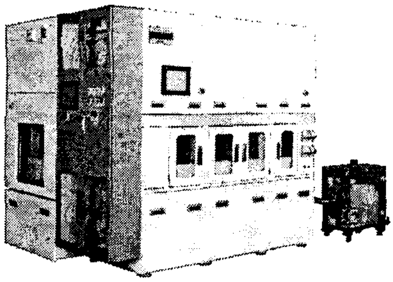
3. MAT's CMP machines and approaches

Established in 1986, MAT has only a short history as an equipment manufacturer but has delivered more than 100 CMP machines and cleaning devices primarily intended for experimentation to at least 30 corporate users in Japan. Figures 4 and 5 show the appearances of its typical manual equipment, MAT-ARW-681MS, and automatic equipment, MAT-ARW-681AC.

While both machines have a one-platen, one-head structure, the MAT-ARW-681MS is manually loaded with the wafers but characterized with extremely high basic CMP performance.

The MAT-ARW-681AC is a fully-automated, dry-in/dry-out, experimental CMP machine equipped with Maiyo's scrub cleaning device and an automatic loading function based on ARW-681MS. Characterized as incorporating an originally designed unique head and having high equipment rigidity, both the units have achieved acceptable processing precision. Additionally, the equipment is extremely compact and designed with a small foot print. Furthermore, the equipment prices are set at an extremely reasonable level.





4. Conclusion

This report has summarized CMP rapidly developing in recent years, except for the semiconductor wiring processes.
In addition, an overview of MAT's experimental CMP machine line-up used there has been introduced.
As one of the few experimental CMP machine manufacturers, MAT will keep digging into CMP even deeper as a processing strategy.

REFERENCES

(*1) Yukihisa Yoshida, Tamotsu Nishino, Jiwei Jiao, Sang-Seok Lee, Yoshiyuki Suehiro, Kenichi Miyaguchi, Tatsuya Fukami, Masafumi Kimata and Osami Ishida, "A NOVEL GROUNDED COPLANAR WAVEGUIDE WITH CAVITY STRUCTURE", in IEEE Proc. MEMS 2003, pp. 140-143.