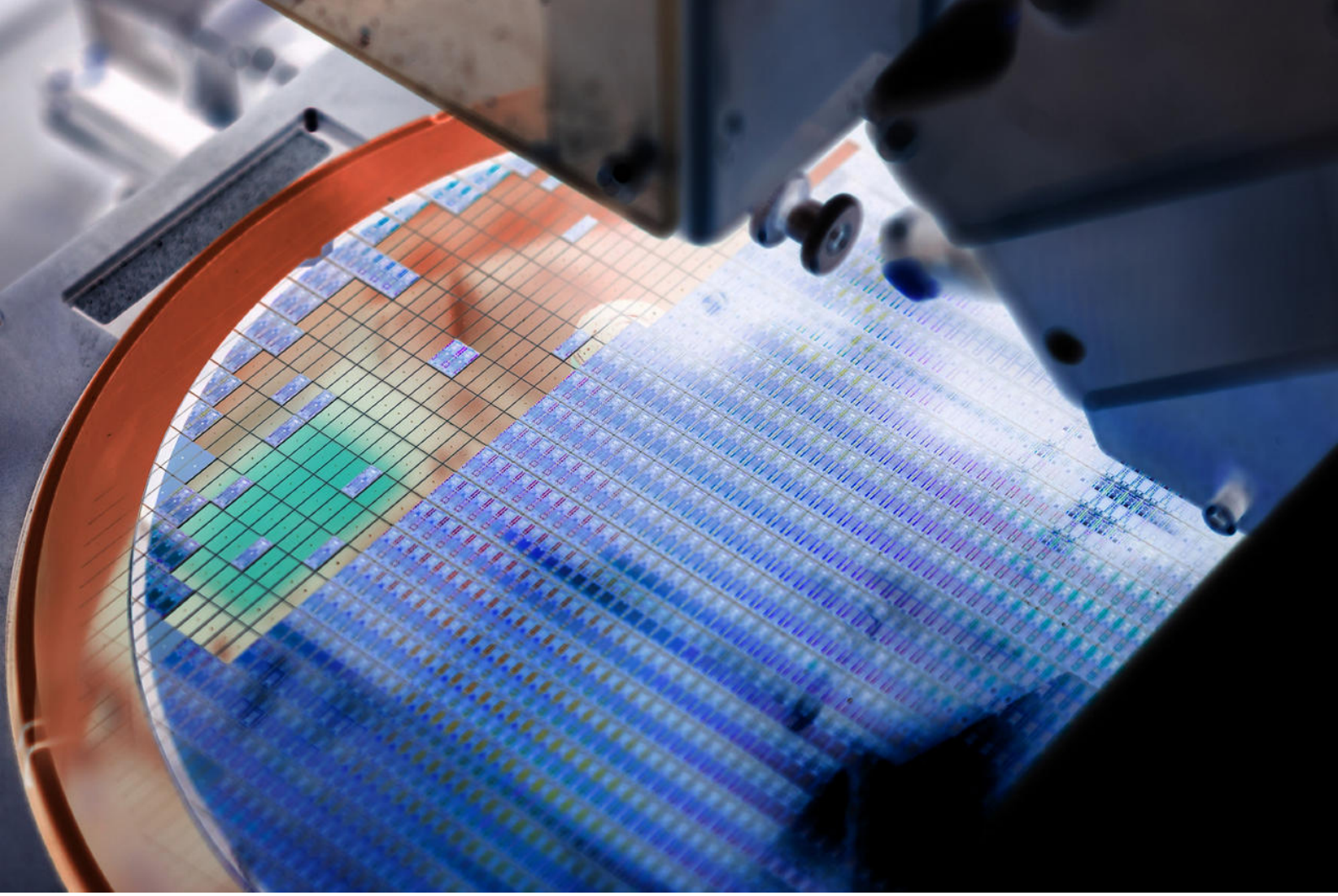

Application Note AN-PAN-1054

在 CMP 过程中对过氧化氢进行在线监测

Semiconductors are the fundamental components of modern electronic goods. With the advent of the digital age and now the current «Internet of Things», smaller, faster, and more powerful processors are in constant demand for many goods and services.

To produce silicon semiconductor devices, the grown silicon ingot material has to be cut, shaped, polished, and cleaned for further processing. Polishing is a key step in obtaining high quality silicon wafers, since it achieves surface planarity for future lithographic steps.

Chemical Mechanical Planarization «CMP» is one of the main technologies used to smooth or polish the silicon wafer surface. Typically, this process consists of mixing deionized water, CMP slurry (a colloidal silicon or alumina liquid dispersion), and hydrogen peroxide (a strong oxidizing agent) in a slurry blending station at a fixed concentration and ratio. The blended slurry mixture is pumped to the day tank for storage or to multiple polishers as part of a chemical delivery unit «CDU».

Because hydrogen peroxide degrades over time,

it is necessary to constantly monitor its concentration online to ensure the CMP process is efficient and repeatable. In this manner, product loss is limited by checking that the CMP slurry is always in specification, and adjusting the mixture if necessary.

In 2019, the Semiconductor Industry Association (SIA) claimed that the worldwide semiconductor sales had been increasing in the last couple of years, with an annual growth rate of 6.81% per year.

Pure silicon ingots, from which the wafers are cut, are incredibly expensive to create. Therefore, any unnecessary waste must be kept to a minimum during the subsequent processing steps.

In the CMP polisher, the slurry mixture comes into direct contact with a single silicon wafer, oxidizing the hard silicon surface to a softer silicon oxide layer, and increasing the **polishing efficiency**. This is kept in a precise balance with the mechanical polishing pad to achieve optimum polishing rates for increased wafer yields.

Hydrogen peroxide is the most widely used chemical oxidizer for the CMP process, and is added to the majority of semiconductor CMP slurries. However, because of its degradation properties over time, hydrogen peroxide concentrations must be measured continuously and throughout the slurry global distribution loop to assure ***in spec*** slurry purity before use. This demands quick online analysis with fast response times as part of chemical replenishment and process control.

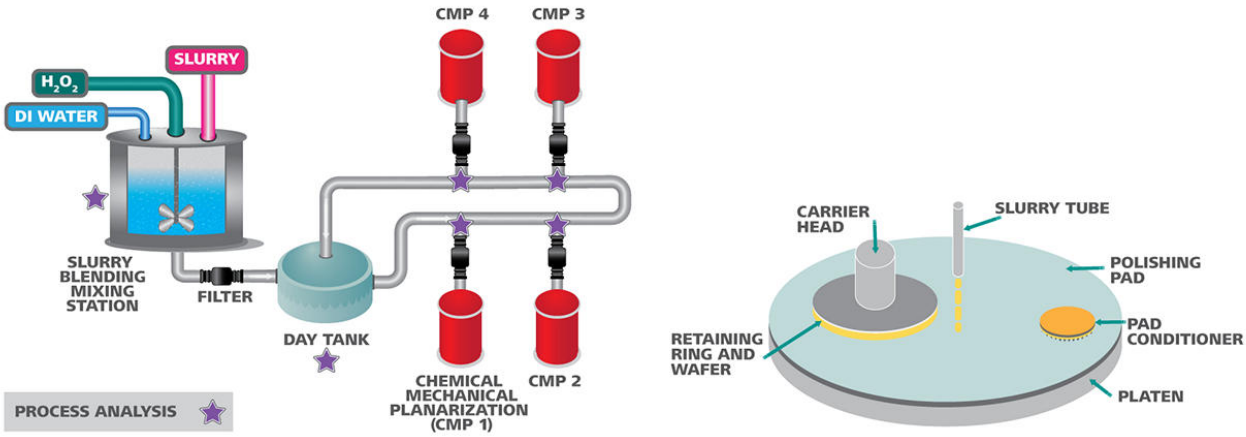

Figure 1. (Left) A typical Chemical Mechanical Planarization (CMP) process. (Right) Top view of a CMP polisher.

APPLICATION

Online monitoring of hydrogen peroxide, pH, conductivity, and temperature is possible with the **2060 Process Analyzer** from Metrohm Process Analytics. The hydrogen peroxide concentration is measured titrimetrically with cerium(IV) using a Pt-ring electrode to determine the endpoint with dynamic endpoint titration (DET). The analysis frequency is typically less than 5 minutes, ensuring timely control of the slurry mixture.

Other combinations of measurements, as well as measurement points taken from a single process stream or even multiple streams, can be realized across the Metrohm Process Analytics product portfolio. All platforms guarantee fast, accurate results continuously available for true process control.

Figure 2. 2060 Process Analyzer from Metrohm for online monitoring of hydrogen peroxide during the CMP process.

Table 1. Slurry measurement parameters

Parameters	Range
Hydrogen peroxide	0–5%
pH	2–12
Conductivity	10–10,000 µS/cm
Temperature	20–65 ° C

BENEFITS FOR ONLINE TITRATION IN THE CMP PROCESS

- **Enhanced wafer yields** with qualified CMP slurry compositions
- **Increased product throughput** with less wafer defects
- **Greater mixing integrity and purity** in the blending station
- **Enhanced control of chemical reaction rates and polishing rates** of the CMP polishing process

CONCLUSION

The Metrohm Process Analytics **2060 Process Analyzer** can measure not only the concentration of hydrogen peroxide in CMP slurry, but also include pH, conductivity and temperature measurements to give an overall health status of the produced CMP slurry mixture without delay.

REMARKS

Other applications are available for the semiconductor industry like: copper, sulfuric acid, and chloride in acid copper baths, acidity in mixed acid etchants, hydrofluoric acid etch, ammonium hydroxide, and hydrochloric acid in standard clean baths.

FURTHER READING

Related application notes

AN-PAN-1012 Electroless Nickel Plating; Semiconductor, PCB industry. Analysis of Nickel ion & Hypophosphite content.

AN-PAN-1028 Monitoring Tetramethylammonium Hydroxide (TMAH) in Developer.

CONTACT

Metrohm Taiwan Ltd.
開封街二段 46 號 5 樓
108 台北市
info@metrohm.com.tw

CONFIGURATION

2060 Process Analyzer

2060 Process Analyzer 是一种在线湿化学分析仪,适用于无数应用。此过程分析仪提供了一个新的模块化概念,由一个称为«主机柜»的中心平台组成。

主机柜由两部分组成。上部包含触摸屏和工业计算机。下部含有柔性取样部,其中放有用于实际分析的硬件。如果主取样部容量不足以应对分析挑战,那么主机柜可以扩展为多达四个额外的取样部机柜,以确保有足够的空间来应对具挑战性的应用。附加机柜的配置方式使每个取样部机柜可以与具有集成(非接触式)液位检测的试剂柜组合使用,以增加分析仪的正常运行时间。

2060 Process Analyzer 提供不同的湿化学技术:滴定法、卡尔费舍尔滴定法、光度测定、直接测量和标准添加入法。

为满足所有项目要求(或满足您的所有需求),可提供样品预处理系统,以确保分析解决方案可靠。我们可以提供任何样品预处理系统,如冷却或加热、减压和脱气、过滤等。