

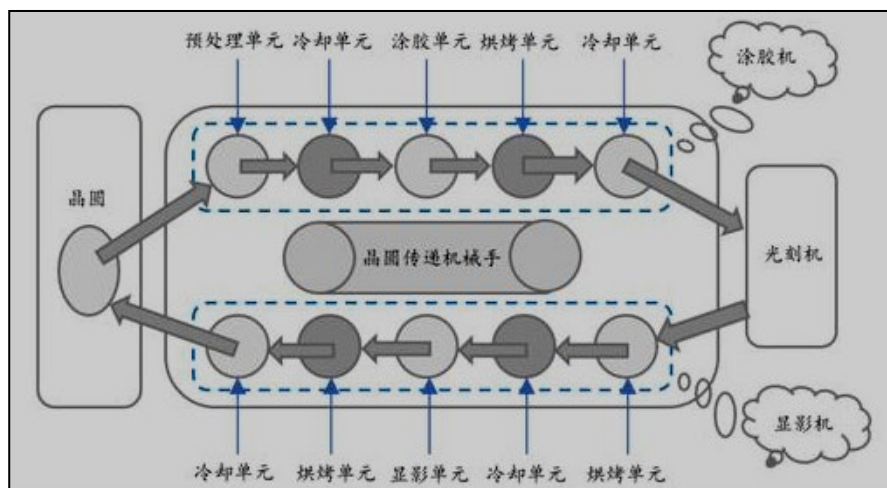
Why Are Automatic Coater/Developer Systems Increasingly Adopting Direct-Drive Technology?



As advanced processes, advanced packaging, and domestically developed semiconductor equipment continue to attract industry attention, critical equipment used in wafer manufacturing is once again in the spotlight. **In the photolithography process chain, coater/developer systems directly affect photoresist film-thickness uniformity and the quality of subsequent pattern transfer, making them essential to advanced wafer manufacturing.** As semiconductor manufacturing advances toward higher precision and higher yield, equipment manufacturers are demanding greater dynamic response, speed stability, and long-term reliability from motion control systems.

A Critical System Behind Photolithography Yield

Automatic coater/developer systems handle the wafer coating and developing processes. During coating, the wafer rotates at high speed to achieve uniform photoresist coverage. During development, developer



solution is applied to form the required circuit pattern. Throughout the process, the speed stability of the rotary stage, the dynamic response of the motion mechanism, and the positioning accuracy of the wafer-handling mechanism directly affect process quality and equipment throughput. **As advanced processes evolve, equipment must deliver not only higher-precision motion control, but also faster production cycles and more stable long-term operation.**

Application Challenges

High Speed Must Come with High Stability

During spin coating and development, the wafer must maintain stable rotation at high speed. Any speed fluctuation may affect photoresist thickness uniformity and, in turn, downstream process quality. Therefore, the equipment must maintain excellent speed stability at process speeds ranging from 2,000 to 6,000 rpm.

Beyond Speed, Precision Is Equally Critical

The equipment frequently performs acceleration, deceleration, and positioning movements. Insufficient dynamic response can reduce production efficiency and affect process consistency, placing higher demands on the drive system.

Small Shaft-System Errors Can Have a Major Impact

Semiconductor equipment has extremely stringent requirements for axial runout, radial runout, and stage operating accuracy. At the same time, the system must accommodate functions such as vacuum holding and heat dissipation/cooling, creating additional challenges for mechanical design.

Kollmorgen Solution

To address the application requirements of automatic coater/developer systems, **Kollmorgen motion control experts developed a high-performance rotary control solution combining the KBM frameless direct-drive motor with the AKD servo drive.**



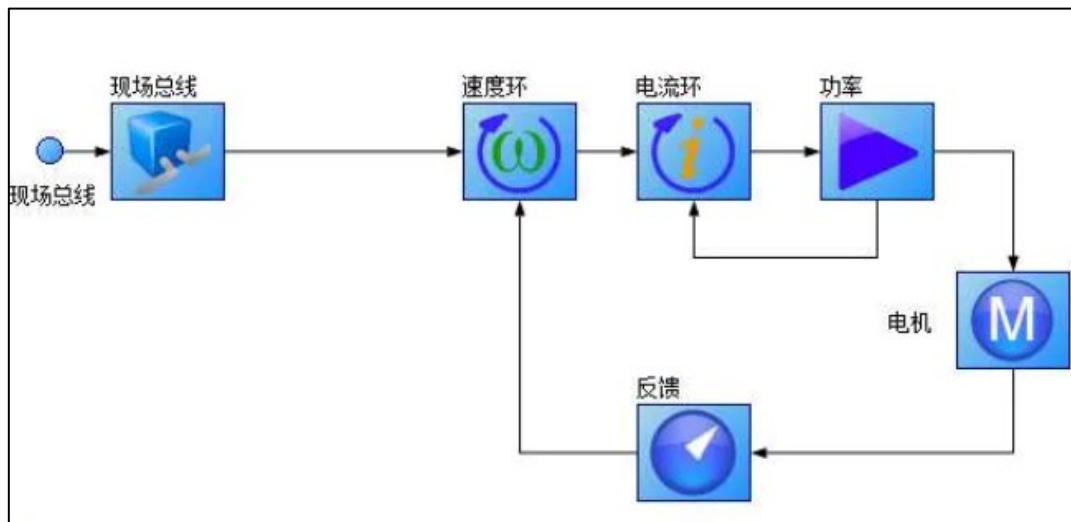
Stable Operation

The KBM frameless direct-drive motor enables customers to build a high-precision motor shaft system, keeping axial and radial runout within **1 μm** to help ensure chuck flatness and stable wafer rotation. Meanwhile, the hollow-shaft design supports vacuum holding, while the water-cooled housing meets heat-dissipation requirements during high-speed operation, enabling continuous operation over extended periods.



High-Speed Control

Automatic coater/developer systems demand more than high rotational speed. They also require strong dynamic response and speed stability. With a **670 ns** current-loop update period and a **62.5 μs** velocity-loop update period, the AKD servo drive delivers precise control under high-speed operating conditions. During the spin-coating process at 2,000 to 6,000 rpm, speed fluctuation can be maintained within **± 1 rpm**, effectively ensuring photoresist uniformity and process consistency.



Velocity-Loop Control Block Diagram

Simplified Development

For equipment designed for wafer sizes from 6 to 12 inches, Kollmorgen offers a range of frameless motor

solutions. A unified, platform-based product portfolio helps simplify equipment development while **supporting future model expansion and product upgrades.**

Project Results and Customer Benefits

Stable High-Speed Rotation

Through coordinated control of the KBM frameless direct-drive motor and AKD servo drive, **the customer achieved stable operation at process speeds ranging from 2,000 to 6,000 rpm**, providing a reliable motion foundation for the coating and developing processes.

Improved Process Consistency

With motor axial and radial runout controlled within 1 μm , together with speed control capability of ± 1 rpm, **the solution helps improve process consistency in wafer processing and provides stable support for uniform photoresist coating.**

Simplified Equipment Design

The integrated design combining a hollow shaft, vacuum holding, and water cooling helps enable a more compact equipment structure and greater system-integration efficiency.

Improved Operational Reliability

The direct-drive solution reduces mechanical errors and maintenance requirements associated with conventional transmission components, helping improve long-term equipment stability.

Explore More Semiconductor Equipment Application Resources

From high-speed spin coating to wafer handling, motion control technology is becoming an important enabler for improving semiconductor equipment performance. Automatic coater/developer systems are just one typical application among the many critical systems used in semiconductor manufacturing. Kollmorgen has built extensive application experience in CMP polishing and grinding, wafer inspection, advanced packaging, semiconductor robotics, and more. [Click here](#) to access **Kollmorgen semiconductor industry solutions and the semiconductor packaging brochure**, and quickly explore motion control technologies and selection considerations for different application scenarios.