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Analysis of Metallic Impurities in Si Wafers Using Fully Automated VPD-ICP-MS

Introduction
Silicon (Si) wafers, also known as "silicon discs," are very thin slices of Si material that act as excellent semiconductors and are widely used in modern electronics and advanced electronic components. Silicon is the most used semiconductor and is a critical element for producing circuits found in everyday electronics, such as computers and smartphones, as well as energy conversion applications, such as highly efficient solar cells. As more industries utilize semiconductor devices and Si wafers in electronic products and services, there is an increasing demand for Si wafers with minimal impurities due to ever-growing scale of component integration on a chip. Since Si wafer production involves many manufacturing steps, an essential component of the quality control (QC) process is to have a reliable technique that can identify metallic impurities that could have been introduced during production.

The standard approach is to check each manufacturing step with a control wafer and analyze the Si wafer's surface for impurities. Total reflection x-ray fluorescence (TRXRF) has been commonly used as an inline analytical tool to analyze metallic impurities on the Si wafer surface because the technique is non-destructive. While the method is ideal for analyzing the film's surface, impurities inside the film cannot be analyzed. Moreover, the detection limit of TRXRF is around 10-100 (ppm), which is too far from the current requirements, and some lighter elements, such as Li, Na, Mg, and Al, are difficult or impossible to analyze. To improve the detection capability of the analysis, vapor phase decomposition (VPD) was developed as a pre-concentration technique for TRXRF.



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This work demonstrates the coupling of an IAS Expert_PS VPD (vapor phase decomposition) system with the PerkinElmer NexION® 5000 ICP-MS, delivering a fully automated, reliable solution for the determination of metallic impurities introduced during Si wafer production, thanks to the ICP-MS' sensitivity and ability to remove spectral interferences when performing trace analysis in combination with a platform that eliminates manual operation and chemical exposure to operators to prevent Si wafer contamination.

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