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Positioning

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Nanopositioning
A Step Ahead

It is almost a cliché among students of creativity that innovation occurs at the intersection of fields. Since nanopositioning is a discipline that has enabled swiftly evolving application arenas as diverse as materials science, genomics, photonics, defense, biophysics and semiconductors, it's unsurprising that its pace of innovation is nothing short of blistering in recent years.

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By its original definition, a nanopositioning device is a mechanism capable of repeatedly delivering motion in increments as small as one nanometer. Lately demands from industry and research have driven requirements in 100th nanometer and below.

While electromagnetics such as piezo materials with flexure guides remain the gold standard for breaking the nanometer resolution barrier, there are several other commercial solutions available today providing repeatable single-digit nanometer step resolution including linear motors, voice-coil drives and frictionless guides such as air bearings and magnetic bearings.

The recent innovation boom both benefits and challenges for engineers and researchers who need to integrate nanopositioning into their applications. Benefits range from enhanced throughput, precision and accuracy to outright enablement of applications that were formerly impossible. But a big challenge is simply keeping up with the latest breakthroughs as they become commercially available, and leveraging the best of them without accepting unnecessary technical risk.

Choosing the right nanopositioning system means, ideally, that the vendor understands the complete application, ranging from specifications for resolution, accuracy, travel and throughput to the development environment, interfacing and synchronization needs.

Of course, cost metrics – which include not only purchase price but cost-of-ownership – are critical for all parties to understand. Deeply functional, well-documented and robust software-support libraries that facilitate rapid application development are increasingly important for accessing advanced functionalities, reducing support costs and compressing time to market in today's multi-platform world. Custom solutions are often required, and the vendor's wherewithal, technical depth, global support capabilities, adherence to international quality standards and organizational stability are key to successful long-term partnerships. Cognizance of today's stringent export control regulations is also important for many customers.

More and more, dynamic issues dominate applications, with novel approaches that benefit real-time high-dynamic applications. These present new opportunities for optimizing process economics.

In fact, optimization is often the application in a nutshell, for example in the rapid fab-floor testing and packaging of today's new generation of silicon photonics (SiP) devices. In these applications, optical elements and probes must be rapidly

Figure 1. A test and alignment system for Silicon Photonics wafers based on closed-loop motorized XYZ micropositioning stages and piezo nanopositioning stages to combine the fastest alignment speeds with the highest flexibility.

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Nanopositioning and Precision Motion Control: A Step Ahead

Nanopositioning mechanisms are key to progress in fields as diverse as materials science, genomics, photonics, defense, biophysics, and semiconductors. A nanopositioning mechanism is defined as a positioning device capable of nanometer or sub-nanometer resolution. There are several types of nanopositioners; the article covers several new designs, including miniature inertia motors, parallel kinematics, voice-coil drives, frictionless air bearing stages, and piezo-driven, flexure guided stages equipped with direct metrology feedback. The pace of innovation in recent years has been blistering.

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