Kaydon white paper

What to consider when specifying bearings for harsh environments

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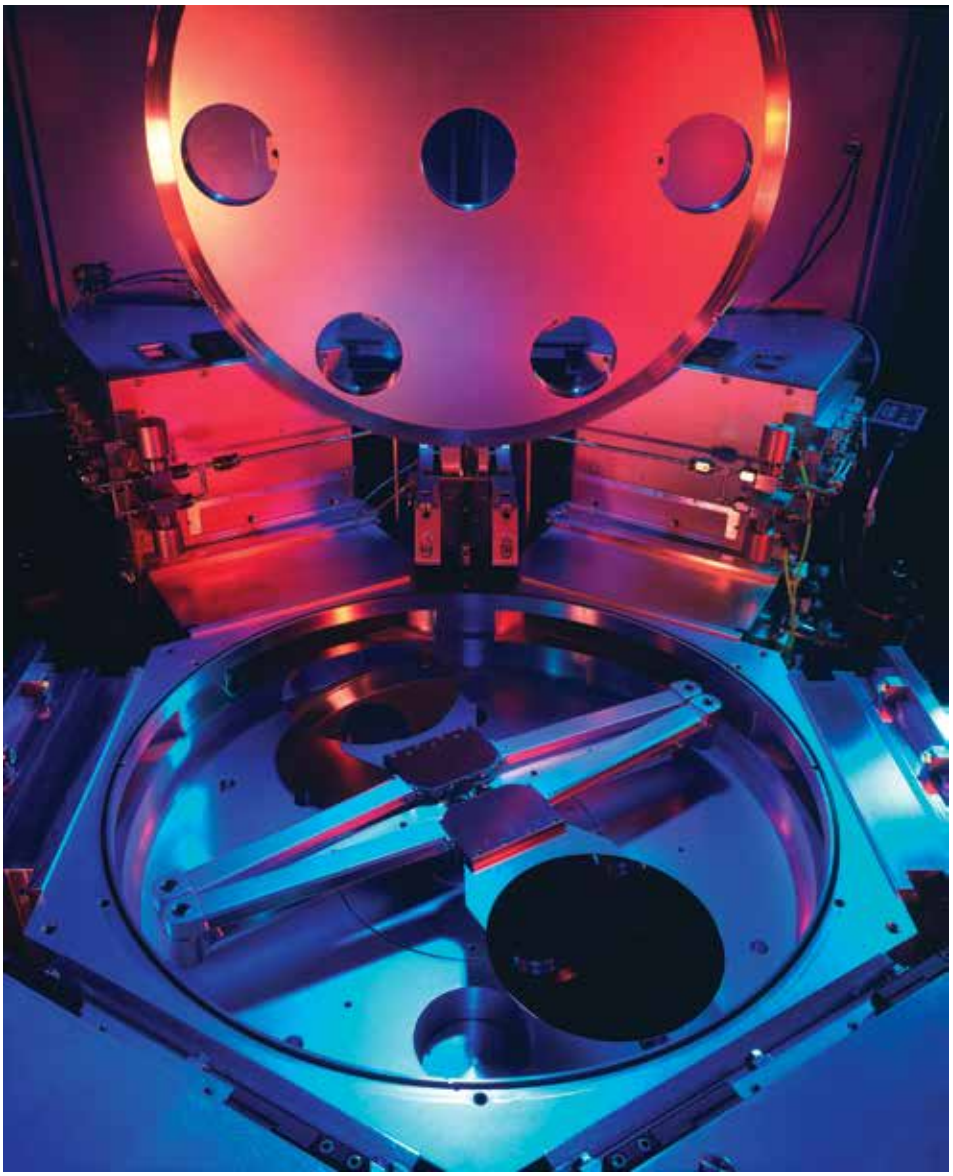
Bearings for harsh environments

Steel bearings, when properly sized and maintained, can operate trouble-free for years in most conventional applications. But the same bearings can have significantly shorter lifetimes when subjected to harsh environments such as those found in semiconductor manufacturing. Hybrid bearings—which combine ceramic rolling elements with stainless steel races—provide a longer-life, corrosion resistant alternative.



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Contamination challenges

The sulfuric acid and other corrosives used to etch silicon wafers can degrade traditional steel bearing materials. Bearings that operate within high-vacuum systems tend to run hotter because they are not able to convect heat away. These conditions will ravage bearing surfaces and break down lubricants, forming damaging particulate matter in the process. Worse still, the resultant debris may also contaminate the vacuum system, requiring hours of clean up and potentially impacting wafers in process.

Bearing lubricant considerations

The bearing lubricants themselves cause further problems in these ultra-clean vacuum systems. Conventional oils and greases contain volatile compounds that tend to outgas when used in vacuum environments. Special lubricants, such as perfluoropolyether (PFPE) vacuum grease, limit outgassing but are prone to polymerization. Metal bearing wear particles can chemically react with fluorine in PFPE grease to form a gummy residue that hinders rolling motion. Because PFPE has a high molecular weight, bearings lubed with PFPE require more torque to rotate than those filled with conventional lubes. Specifying the optimal lube and fill rate requires detailed application review and prioritization of performance objectives.

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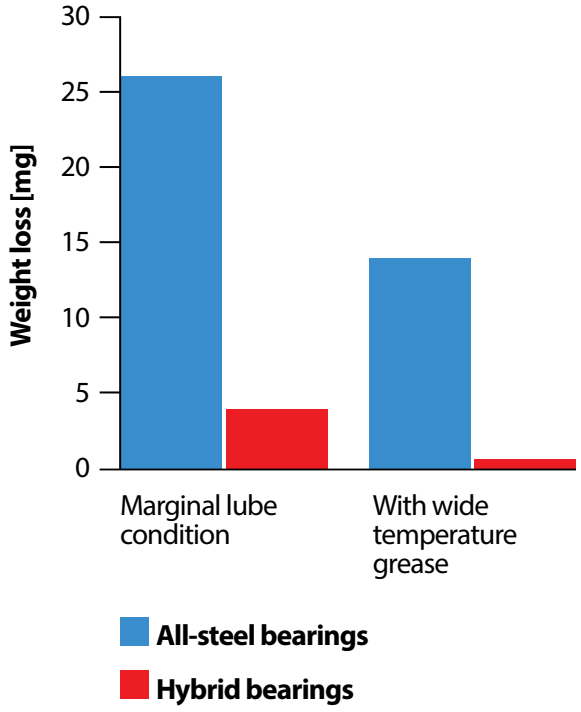
Hybrid bearing solution

Applications requiring low particle generation, high accuracy, and/or high speeds, as well as those that must operate in adverse or marginal lube conditions, can benefit from hybrid bearings, which combine stainless steel races with balls made from ceramics such as silicon nitride. Tests have shown that significant reductions in particle generation can be obtained with hybrid designs that incorporate the use of ceramic rolling elements on hardened steel races. In addition, the physical properties (precision, hardness, light weight) of the ceramic rolling elements provide benefits such as improved repeatability, low torque, high stiffness, and resistance to wear under marginal lube conditions.

Ceramic balls are essentially inert and corrosion resistant, and have a low friction coefficient. Moreover, ceramic balls eliminate adhesive wear that can occur in all-steel, metal-on-metal ball bearings. This makes hybrid bearings an excellent choice for applications with marginal lubrication or harsh operating requirements.

Hybrid bearings reduce wear and particle generation



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