The Need for Optical Tables

In the modern research or application laboratory it is often necessary to conduct experiments or make measurements in a vibration-free environment. Optical systems with multiple components which must be individually mounted and aligned in a precise and rigid fashion are particularly vulnerable to vibration-induced performance degradation. Vibrational sources are common in virtually every environment. Vacuum pumps, elevator mechanisms, seismic activity, air conditioners, heat pumps, road and rail transport, and many other sources all contribute to the vibrational background noise that is coupled to the foundations and floors of the surrounding buildings.

Because visible light has a wavelength of approximately 0.5 μm, interferometry-based experiments (including holography) may be impossible to perform in the presence of vibrations of even submicron amplitude. Many laser applications involve focusing the beam to a waist of only a few microns in radius. If the position of this spot is critical to system performance, then vibrations with amplitudes in the micron range can ruin an experiment. Optical and mechanical machining or probing of semiconductor wafers requires similar stability. Furthermore, many experiments involve mechanical elements that move or vibrate and therefore must be vibrationally isolated from all other critically aligned elements.

To be useful, the surface on which an optical system is mounted must satisfy several basic requirements. It must provide a rigid base on which optics can be mounted and aligned reliably, with both long-term stability and no inherent vibrational resonances. It must successfully damp any vibrations caused by motorized or moving parts in the experiment, thus preventing these vibrations from influencing critical optical elements. Finally, it must isolate the experiment as a whole from ambient background laboratory vibrations. If these criteria are not met, undesirable effects often result—an individual component, or the system as a whole, may not function properly; valuable data may be buried in random noise; or data may be totally misunderstood and wrongly evaluated as a result of vibrationally induced noise.

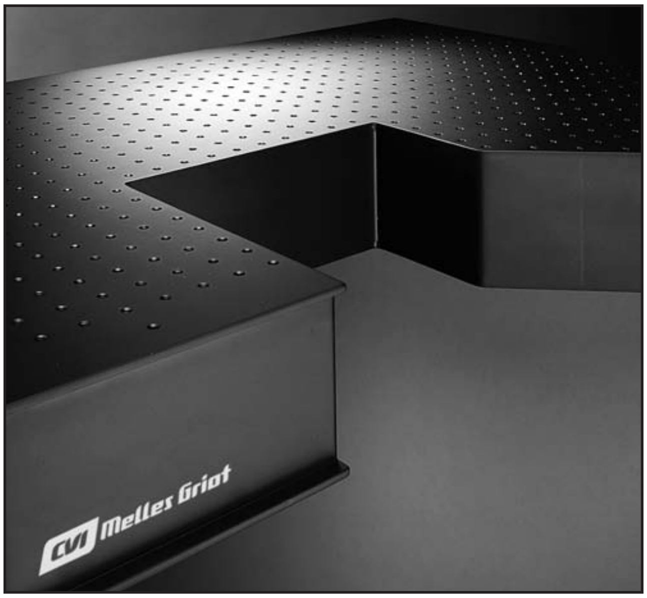
To help solve these problems, optical tables and breadboards of various designs have been developed. An ideal optical table is designed to maintain a rigid and flat upper surface without being overly massive. The table is then mounted seismically, usually on air springs, to prevent the coupling of ambient background vibration. In the past, tabletops have been made from granite, concrete, wood, steel, and a variety of unusual composite structures in attempts to improve performance while keeping weight at an acceptable level. Each has advantages and disadvantages, but it is now generally accepted that the best overall performance is achieved by using a composite structure consisting of a sandwich of metal honeycomb bonded between flat metal plates.

The ambient vibrational noise in the structure of a building is generally in the 4- to 100-Hz range; consequently, vibration-isolation mounts (supports) are designed to minimize transmitted vibrations at frequencies above a few cycles per second. Energy cannot be transferred from one type of vibration to another if separated by a large difference in frequency. The resonant frequency of CVI Melles Griot isolation supports is typically 5 Hz or less. The resonant frequency of a CVI Melles Griot tabletop is well above 100 Hz. This separation between the resonant frequencies of the tabletop and its support system ensures that no energy coupling can take place.

As with any other high-performance product, optical table design is an ongoing process, with new technology and ideas being incorporated continually to enhance performance. CVI Melles Griot product development has been focused particularly on three areas:

- Improving the performance of the tabletops by using advanced damping technology
- Developing a cost-effective table with performance well in excess of that needed for most applications
- Addressing the often overlooked issue of horizontal isolation in the vibration isolation supports

Most commercial isolation mounting systems for optical tables directly damp vertical motion by use of a damping orifice in the air springs. There is no direct horizontal isolation and damping. Instead, they rely on the inefficient coupling between the vertical and horizontal modes. CVI Melles Griot horizontally enhanced isolators incorporate a long pendulum mechanism designed specifically to provide direct horizontal damping.



Optical tables provide a stable flat working surface.