M-850 Hexapod Advances Research in Dental Biomechanics

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Dental biomechanics deals with the interactions between dental materials, treatment instruments or dentures and the reaction of teeth, biological tissues, etc. to mechanical stresses. A wide spectrum of force systems occur here with masticatory forces exerting loads to 380 N and torques to several Nm.

At the same time, movements of several orders of magnitude are involved: orthodontic equipment can change the position of teeth by up to several mm, whereas—during mastication—teeth are deflected by less than 100 µm and implants by as little as a few microns or less. These combinations of small forces with large deflections, on the one hand, and large forces and extremely small deflections on the other, represent a challenge with respect to the biomechanical metrology.

To deal with this challenge, the Dental Clinic of the University of Bonn designed the HexMeS (Hexapod Measuring System) based on the M-850.50 Hexapod. The ability to move in 6 degrees of freedom and the combination of small dimensions, very high stiffness and resolution of less than 1 µm (1 arcsec) were the key reasons for choosing the M-850 system.

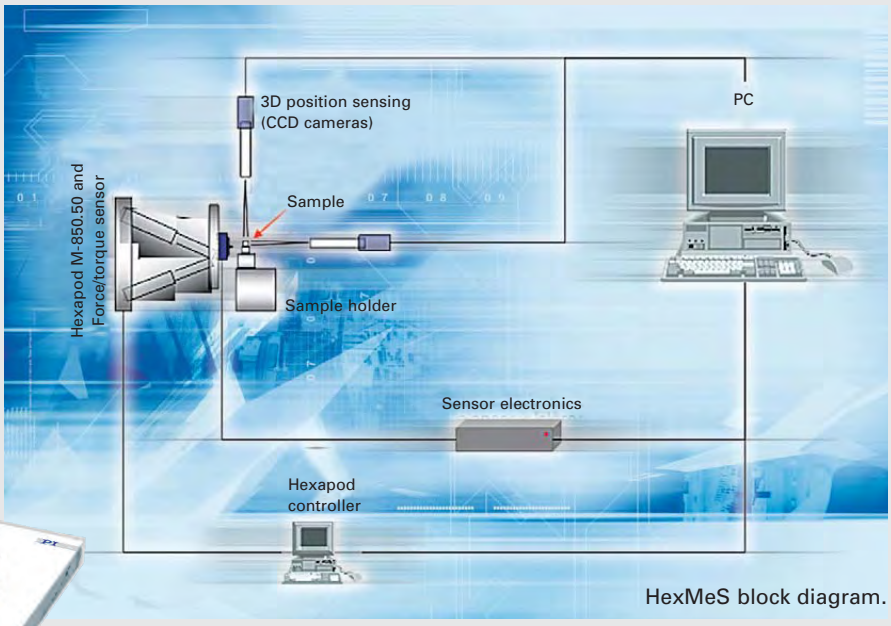
HexMeS also features two 6-component force/torque sensors for the Hexapod with measuring ranges of 12 N (120 Nmm) and 130 N (10 Nm) respectively and an optical detection system equipped with 3 CCD cameras.

Because of its high stiffness (100 N/µm), sample deflections can usually be calculated directly from the Hexapod motion.

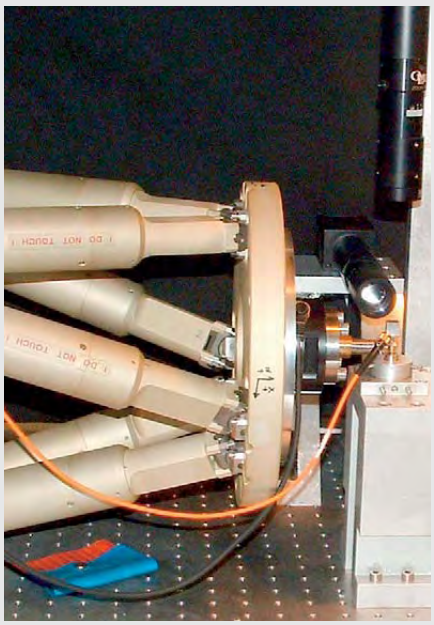
For high-load testing—simulations of mastication in the 100 N range—the optical portion of the HexMeS is used. It resolves sample deflections to 0.7 µm / 0.2 arcsec.

The M-850-based HexMeS currently represents one of the most flexible measuring systems in the field of dental biomechanics. Its efficiency and the broad spectrum of its application have been demonstrated in a whole series of experimental investigations into dental implants, telescope crowns and orthodontic prostheses.

Load testing of a double crown.



HexMeS block diagram.



The New M-824 Hexapod—Smaller and Vacuum Compatible

M-824 6DOF micropositioning system–vacuum model.

Application Examples

- Micromachining
- Micromanipulation
- Life sciences
- X-ray diffraction measurements
- Semiconductor handling systems
- Tool control for precision machining & manufacturing

Compact Innovation

For the last 15 years, PI has been the global leader in high-precision hexapod positioning technology.

The new M-824 Hexapod was developed for space-critical 6D positioning and alignment applications. Its low profile–only 188 mm–has been made possible by the folded-drive-train design, a parallel drive shaft / motor configuration.

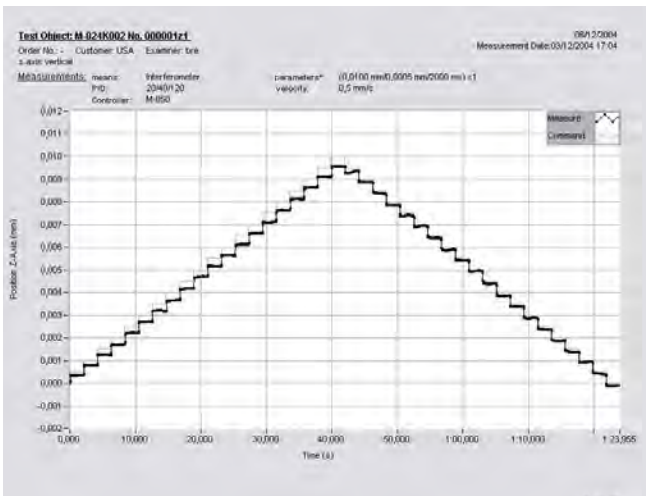
The platform can travel up to 45 mm in each linear axis and up to 25 degrees in each rotation axis. The design resolution of each individual strut is 7 nm. The minimum linear incremental motion of the Hexapod is 300 nm and it achieves a repeatability of ±0.5 µm. Most importantly, the high-geared design is self-locking to 10 kg and provides very high position stability devoid of servo-dithering issues that plague some other designs.

Vacuum Designs

Because many of today's demanding positioning tasks are performed in a vacuum, PI provides a variety of high- and ultra-high-vacuum compatible micropositioning and nanopositioning products. The new M-824 Hexapod is available for atmospheric pressure as well as for pressures down to 10^{-6} hPa (model number M-824.3VG).

Special Features at a Glance

- Vacuum compatible
- 10 kg load capacity
- Travel ranges to 45 mm, rotation to 25 degrees
- 7 nm actuator resolution
- Minimum incremental motion to 300 nm
- Repeatability ±0.5 µm
- Very compact design



The interferometer test shows the highly repeatable minimum incremental motion of 500 nm.

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