Ultra High Speed Imaging System Helps Unlock Understanding of Dynamics of Operation in Microdevices ...

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DRS Hadland, formerly Hadland Photonics, has supplied the Department of Measurement, Control and Microtechnology at the University of Ulm with an ultra-high speed digital imaging system to help them gain a greater understanding of the dynamics of moving parts in microdevices.

The measurement of position, velocity and acceleration of moving parts in microdevices is of great interest in the rapidly growing field of microsystem technology in order to solve the problems needed to allow evolution from laboratory use into industrial mass production. Such research is targeted towards gaining a better understanding of the dynamics of the moving parts in microdevices.

For the visual investigation of dynamics in microdevices high optical magnification is necessary because the dimensions of microsystem components are very small. Therefore, velocities of parts of such microdevices appear to be extremely fast and time constraints are very small.

The University of Ulm microtechnology research group has combined an intense pulsed light source, the ultra-high speed IMACON 468 camera from DRS Hadland and a standard optical microscope in a test rig to allow the analysis of nanosecond timescale dynamics of a series of different microdevices.
To ensure optimal light input through the microscope a high pressure Xenon lamp was specially adapted to fit in its lamp housing. The microscope was set up to image the magnified object onto the IMACON 468 ultra high speed camera. The prototype of this set-up for dynamic testing of microdevices was exhibited at the Hannover Industrial Fair in 1999.

The IMACON 468 received the Queens Award for Technology for its flexibility of operation and high performance in providing quantitative digital image analysis at high spatial resolution. Without mechanical moving parts the IMACON 468 ensured no vibration influences onto the tiny microdevices under study.

Using a proprietary design the IMACON 468 channels light through optical relays onto a special eight sided beamsplitter from where it passes onto eight intensified CCD units arranged in a circle around the beamsplitter. Production of eight discrete image frames through a single optical input not only provides very high spatial resolution but overcomes the drawback of image displacement optical anomalies caused by traditional high speed cameras use of several high speed camera mounted side-by-side.

Operating at up to 100 million frames per second using gated image intensifiers the IMACON 468 has provided the University of Ulm with a camera-microscope combination that is able to generate high contrast images (256 grey levels) with exposures as short as 10 ns and magnifications of up to 500 times.

Using this new technique Professor Hofer's research group has been able to analyse the motion of a 350 micron microturbine rotating at 200,000 revolutions per minute. In addition, they have looked at the heat induced stretch in a thermal micropump with a heating cycle of 2 microseconds, the oscillation of a microrelay with a switching time of 400 microseconds and to build up a detailed understanding of the mechanism of bubble-jet formation in thermal ink-jet printheads measuring 60 micron square. Using the technique to study microactuators, tiny devices that convert electrical energy into mechanical energy, the group has helped develop a new generation of diamond microheaters.

The IMACON 468 system has permitted previously impossible recording and analysis of the dynamics of operation of a series of microdevices by the Microtechnology group at Ulm which will lead to improvement of their design and, consequently, to the improvement of quality and lifetime of each microdevice. ■