Use of PI Parallel Kinematic Machines (PKM) in Industrial Testing

Photothermics, a non-destructive testing method, uses PI Hexapods to orient test samples in University of Bremen study

Fig. 1: PI Hexapod with test piece in place

Automatic testing methods in industrial production are an important component of quality assurance, non-destructive testing being the ideal objective. Photothermics is a method which has seen considerable development in recent years. In it, a laser source is used to heat up a spot on a test sample and the propagation of the heat wave is followed with appropriate sensors. By comparing the measured values from the sample with those from a calibration model, the sample can be characterized according to specific criteria. This makes it possible to ascertain layer thicknesses or hardness penetration depths and to detect cracks, pores and damage from local overheating while grinding.

The University of Bremen and the Bremen Institute of Industrial Technology and Applied Work Science (BIBA) have developed a system with which photothermal measurements on arbitrary surfaces can be performed. The kinematics of this system consists a six-axis PI M-840 Hexapod (Fig. 1) which can be coordinated with various common machines such as industrial robots or machine tools. Test samples used included medical implants.

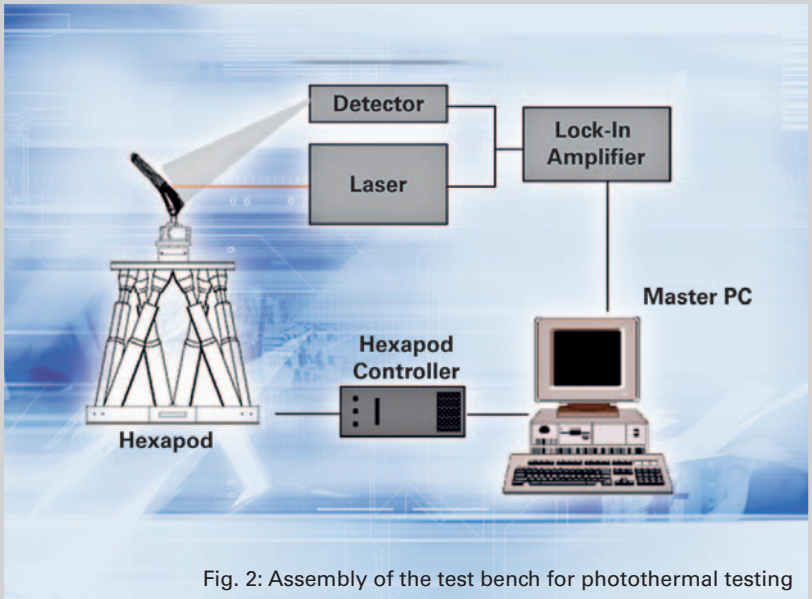

Fig. 2: Assembly of the test bench for photothermal testing

In the overall system concept (Fig. 2), a master PC assumes control of the whole testing unit, consisting of detector, laser and lock-in amplifier. The Hexapod controller and the Hexapod constitute the kinematic unit. The laser receives the command to switch on the laser source via the lock-in amplifier, through which the detector sends the heat wave propagation data to the master PC. The Hexapod controller receives its motion commands in Cartesian coordinates from the master PC. The controller performs the necessary coordinate transformation, chooses a trajectory, and sets the corresponding targets for the individual Hexapod struts.

Photothermics requires a defined angle of incidence of the laser beam. Using the technique on curved surfaces requires precise knowledge of the orientation and position of the areas to be tested. The system extracts this information from the geometric data describing the sample, and generates the appropriate control sequences. In addition, the test piece is scanned in the current mounting with fringe projection techniques before photothermal inspection. The fringe projection data is used to subdivide the scanned geometry into constituent, relatively-flat segments and establish their orientations. The normal vector of each segment is used to generate move instructions for the Hexapod which properly align the test sample with respect to the laser beam.

Using the industrial-class system presented here, it is possible to eliminate most of the actions which previously had to be carried out manually. The 6 degree-of-freedom Hexapod (6 DOF) can orient the test piece almost anywhere in space, opening new areas of application to photothermics in complex surface inspection.