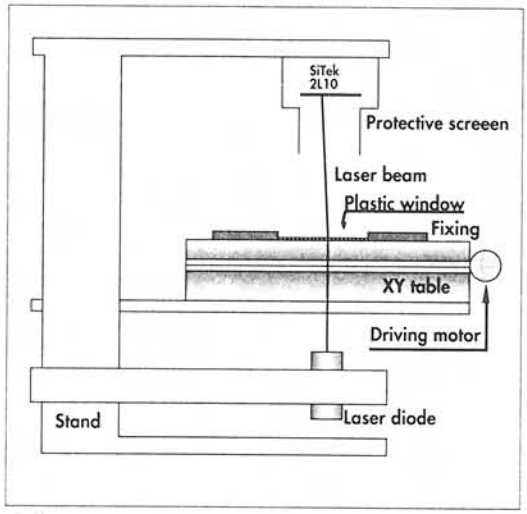
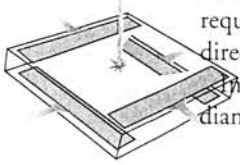
Routine checking of optical windows

A company manufacturing polycarbonate windows had difficulty in maintaining the required quality. Too many windows had to be rejected after post-production checks. However, the company believed that the number of rejections could be greatly - reduced if all plastic windows were measured up directly after removal from the injection moulding machine. This should then provide the opportunity for variation of the injection parameters and thereby continuously manufacture windows of the required precision. Each measurement should not take no more than 30 seconds, and in order to achieve a sufficiently good final underlay it should cover 30 points distributed over the entire 26 x 36 mm large surface on every window.



The solution to the problem

It was immediately obvious that the measurement must take place automatically and be suitable for operation by computer. The requirement was that a beam of light, when passed perpendicularly through the plastic window, had a maximum angle of deviation of 0,25 mrad. By recording the change in position of a beam of light that first strikes a position sensing detector (without passing through the window) and then striking the detector after having passed through the window, one can obtain the required angle of deviation as arc tan for the change in position divided by the distance of the detector from the window. That being so, one must select a collimated beam of light with a certain diameter, which means that the position sensing detector must be able to recognise the so called light centre of gravity. It is possible to solve the task with at CCD, but that will require a lot of programming and thus require higher development costs. A PSD will do this directly.



In this example, the beam of light used had a diameter of ca 3,5 mm. If the detector is placed at a distance of 200 mm from the window, and we are interested in an angle of deviation of the order of 0,25 mrad, this corresponds to a shift in the beam of light of 0,00025 x 200 mm = 0,05 mm in different directions on the PSD detector. This, in turn, means that the detector must have an active surface of at least 4 x 4 mm. We decided to chose a SiTek 2L10 which has an active surface of 10 x 10 mm, thus providing a significantly grater margin for mounting and handling of the measurement equipment.

Building up the measuring system

A fixing for the windows was mounted on the motor-driven cross-table of a microscope. Since the xy-motion is so constructed as to function on the horizontal plane, the window is placed on the same plane making it easier to change the object being measured. The PSD detector was mounted above the xy-table, with the active surface downwards and the laser diode underneath, pointing upwards. In this way it was easier to shield the PSD from any surrounding light and additional shielded by means of a tubular light shield in front of the detector. The appearance of the measuring equipment can be seen on the pictures. SiTek´s PM-kit was used for the electronics and a PC chosen to guide the measuring, with the applications being written in Visual Basic programme.

The performance of the measuring equipment

The PM-kit has a resolution of 1/2000 which, on the 10 mm detector used, gives 5 µm. This in turn means that an angular resolution of 0,005/200 radians = 0,025 mrad when the distance between the measured object and the detector is 200 mm. Thus the resolution is one-tenth of the maximum allowed deviation. The total measurement time to measure all 30 points is 16 seconds.