Position Sensitive Detectors - Device Technology and Applications in Spectroscopy

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Abstract

This thesis deals with the development, processing and characterization of position sensitive detectors and, in addition, to the development of compact and cost effective spectrometers.

Position sensitive detectors are used to measure, with great accuracy and speed, the position of a light spot incident on the surface. Their main use is for triangulation, displacement and vibration measurements.

A type of position sensitive detector based on the MOS principle and using optically transparent indium tin oxide as a gate contact has been developed. This type of detector utilizes the MOS principle where an induced channel forms beneath the gate oxide in the surface of the Silicon substrate.

One and two dimensional detectors have both been fabricated and characterized. The first measurements showed that the linearity did not fulfil expectations and it was suspected that stress induced by the gate contact could be the reason for the seemingly high nonlinearity.

Further investigations into both the p-n junction and the MOS type position sensitive detectors lead to the conclusion that the indium tin oxide gate is responsible for inducing a substantial stress in the surface of the detector, thus giving rise to increased position nonlinearity. The heat treatment step which was conducted was determined to be critical as either a too short or too long heat treatment resulted in stress in the gate and channel leading to position nonlinearity. If a correctly timed heat treatment is performed then the detector's linearity is in parity with the best commercial position sensitive detectors.

In addition, the development of very small, compact and cost effective spectrometers has been performed with the aim of constructing devices for use in the process industry. The development of a wedge shaped array of Fabry-Perot interferometers that can be mounted directly on top of a detector makes it possible to construct a very compact spectrometer using the minimum amount of optics. This wedge interferometer has been evaluated by means of array pixel detectors and position sensitive detectors for both the infrared and the visible wavelength ranges.

When used with a position sensitive detector it is necessary to use a slit to record the intensity of the interferogram for many points over the detector, equivalent to pixels on an array detector. Usually the use of moving parts in a spectrometer will impose the use of high precision scanning mechanisms and calibration. By using a position sensitive detector for the interferogram readout both the position and the intensity are known for every measurement point and thus the demands placed on the scanning system are minimized.

Keywords: Position sensitive detectors, MOS type PSD, compact spectrometer