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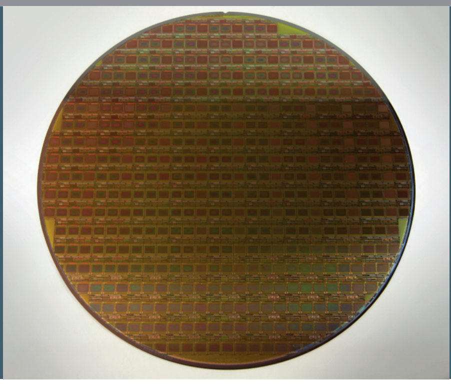
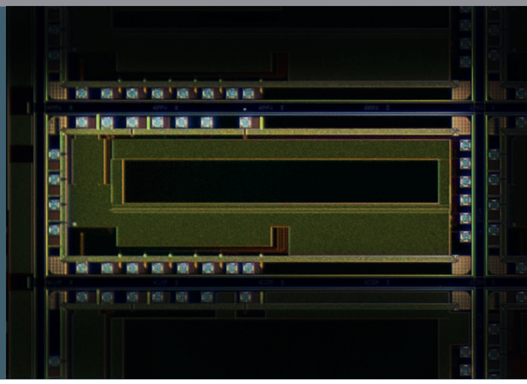




1 *Wafer with optional stitching capability.*
2 *Line sensor micrograph.*

CMOS LINEAR SENSOR FOR SPECTROSCOPY APPLICATIONS

Fraunhofer Institute for Microelectronic Circuits and Systems IMS

Finkenstr. 61
D - 47057 Duisburg
Phone +49 203 37 83-0
Fax +49 203 37 83-266
www.ims.fraunhofer.de

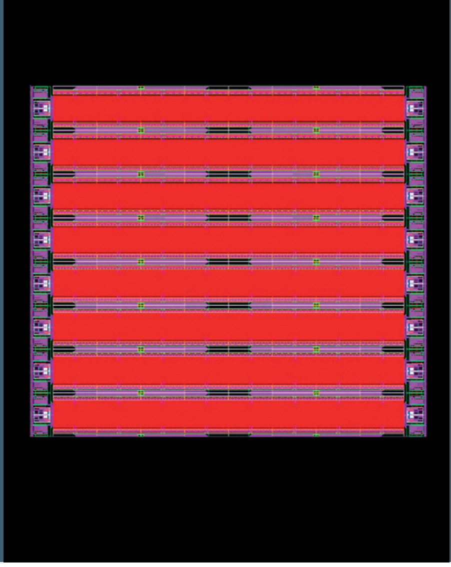
Contact
Michael Bollerott
Phone +49 203 37 83-227
vertrieb@ims.fraunhofer.de

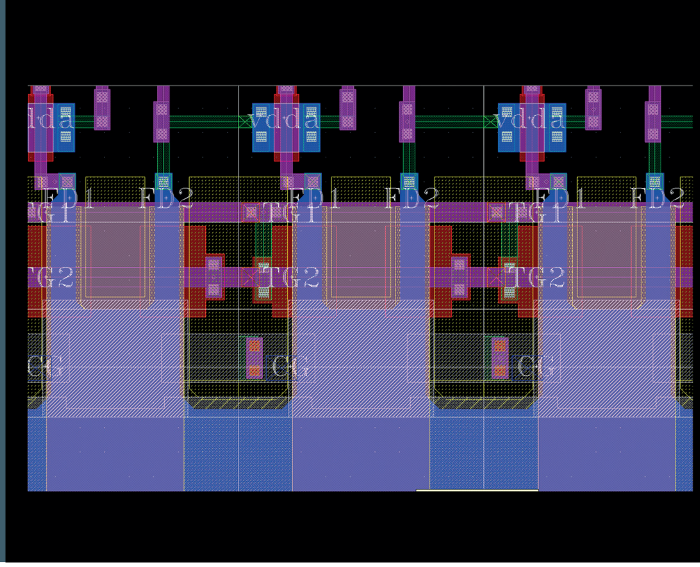
Many industrial applications require linear photosensors which exhibit high sensitivity and low noise. As an example, the optical emission spectroscopy (OES, spark or laser induced spectrometry) delivers the information about the qualitative and quantitative composition of an analyte. Since 1960, photomultiplier tubes (PMT) are used as standard detectors in the field of spark spectrometry due to their extremely high sensitivity in the ultra-violet (UV) region and the possibility of time-resolved measurements (TRM).

Since a PMT can detect only one signal at a distinct position in the spatially distributed spectrum, lots of PMT's are needed to equip a universal spectrometer. Therefore, these devices could not fully satisfy the market demands. On the other hand, widely used charge coupled device (CCD) linear sensors are able to detect the emitted visible spectrum from 400nm-1000nm simultaneously but usually require multiple integrations to pick up the information from the emission lines of interest. A CMOS approach provides a good alternative to PMT´s and CCD´s, as it offers both time-resolved measurement capability (TRM) and spatial resolution. A lateral drift-field photodetector (LDPD) based CMOS linear sensor utilizes time gating accompanied by non-destructive readout and charge accumulation over several cycles. This enhances the signal-to-noise ratio (SNR), hence significantly reducing measurement cycle times at increased OES measurement resolution.

The LDPD-based CMOS linear sensor was developed and optimized at Fraunhofer IMS, Duisburg.

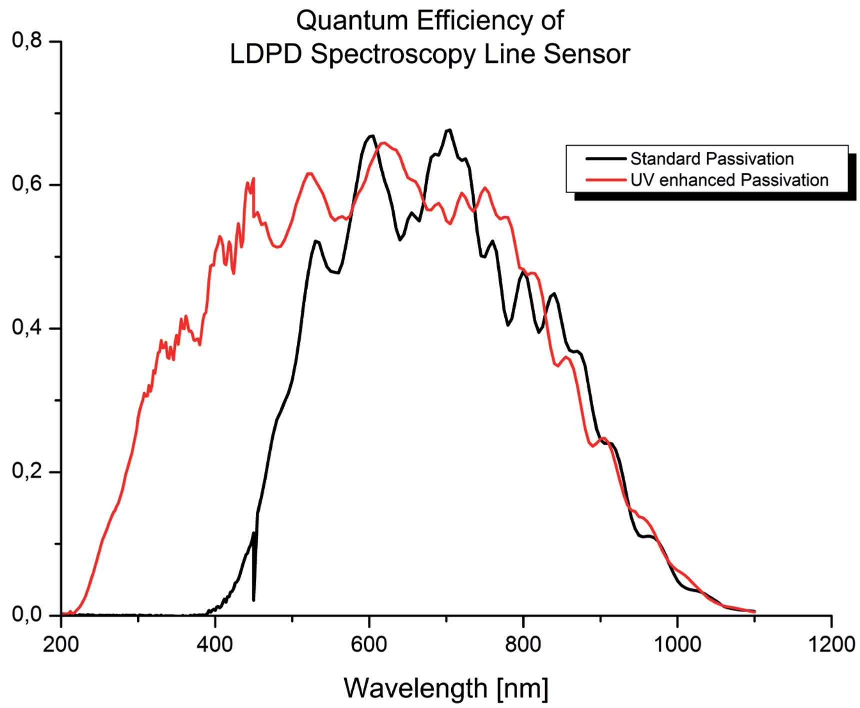
The designed CMOS linear sensor is sensitive in the UV part of the spectrum and exhibits high spectral responsivity and high DR (Dynamic Range), which can be achieved also through the accumulation of the signal charge over several measurement cycles without





the need of resetting the sense node. Minimum dark current enables long integration times (~10 sec.).
The LDPD (lateral drift-field photodiode) based CMOS linear sensor incorporates fast charge transfer, with reduced crosstalk by means of technological improvements through extensive LDPD-device simulation and optimization.

Non-destructive readout together with the possibility to perform time-resolved measurements makes the developed CMOS linear sensor the ideal detector for spark atomic emission spectroscopy, providing a substitute for hybrid detectors in general.



Summary of 368 × 1 pixels CMOS linear sensor characteristics

Sensitive area	3680 µm × 200 µm
Pixel pitch	10 µm
Conversion gain	17 µV/e⁻
Responsivity @ 525 nm	530 V/(µJ/cm²)
Quantum efficiency @ 525 nm	60 %
Linearity	0.5 %
Saturation capacity	59 ke⁻
Sense node capacitance	7.50 fF
Signal-to-noise ratio	47 dB
Dynamic range	63 dB
Read noise	38 e⁻
DSNU1288	7.5 mV
PRNU1288	1.6 %
Electrical crosstalk	< 4 %
Dark signal (T ≈ 22 °C)	75 mV/s
Process	0.35 µm 2P4M CMOS + LDPD + UV-Transparent Passivation

3 *368 × 8 stacked linear sensor example configuration.*

4 *LDPD Pixel layout with floating diffusion and drain diffusion configuration.*

5 *UV-enhanced spectral sensitivity of the LDPD linear sensor.*