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Ultra-thin Uncooled Integrable-on-Chip Detector to Measure Wide Infrared Radiation Residue in Lithography Exposure and Metrology Inspection Tools

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INTRODUCTION

The source of extreme ultraviolet radiation used in the most advanced lithography process may produce unwanted infrared components passing through the illumination and projection lenses and reaching the wafer surface.

These infrared residues are unwanted. Their timely detection and reduction/elimination is essential for the imaging quality.

We report a new IR HgCdTe photodetector with a spectral response from 2 to 12 µm, with acceptable detectivity and noise level at room temperature. The detector is UV- and visible-light blind, uncooled (300K), and sensitive to weak IR radiation

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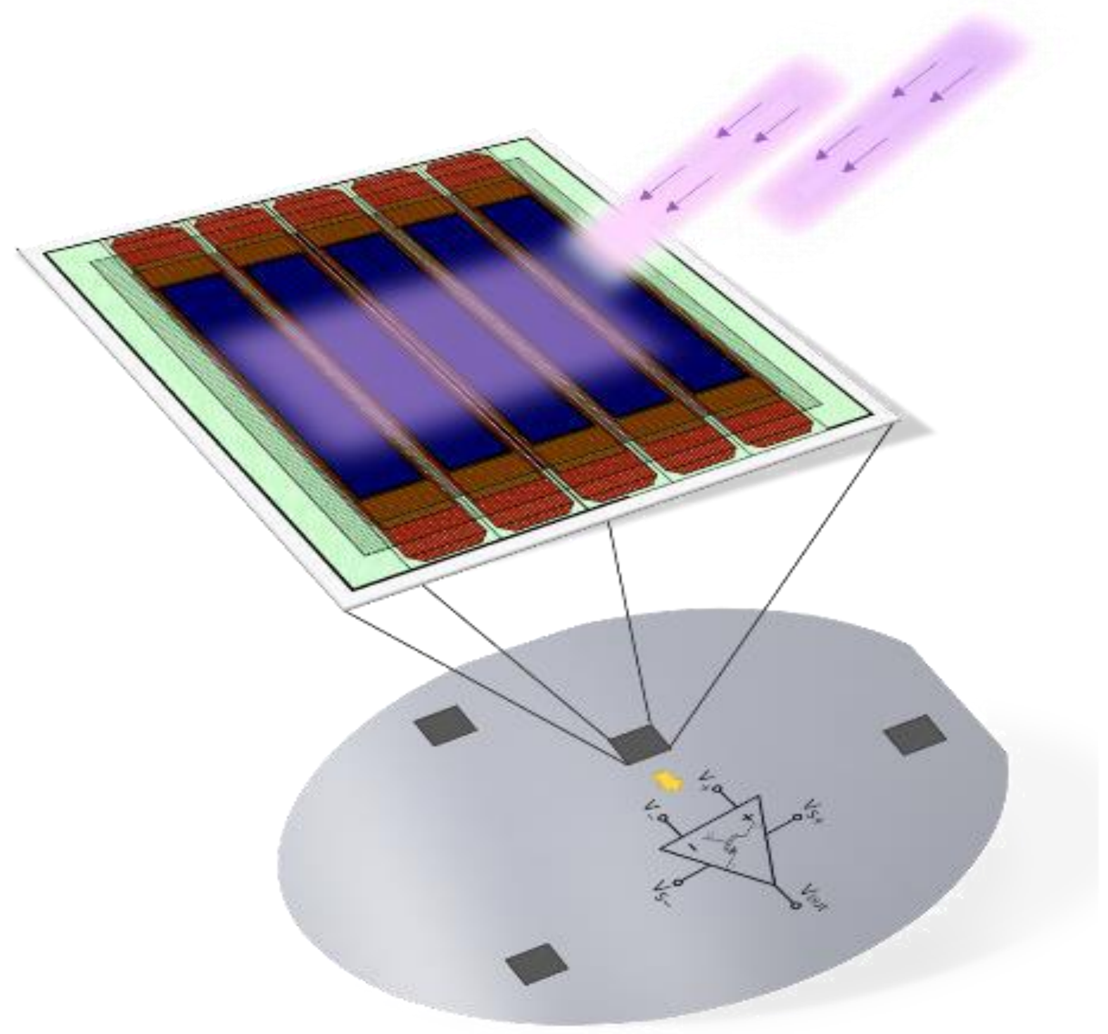

Fig. 1. An array of the IR detectors will be assembled on a portable carrier together with the readout electronics, to allow performing fast measurements inside multiple lithographic machines.

The IR detector is developed, produced and tested by the company VIGO Photonics SA, in cooperation with the Institute of Applied Physics in Warsaw, Poland and the Technical University in Delft, the Netherlands

METHODS

The IR detector is a photovoltaic multiple junction module (PVM), based on a proprietary HgCdTe heterostructures from VIGO Photonics.

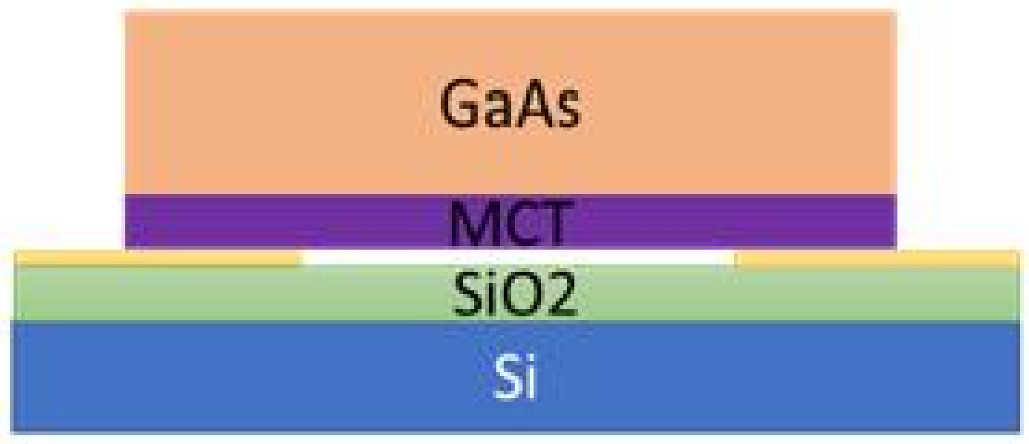

Fig. 2. The photovoltaic multiple junction photodetectors PVM heterostructure cross-section.

A critical requirement was the overall thickness of the device to be less than 700 µm as it is located among CMOS circuits and contacted to them by wire bonding

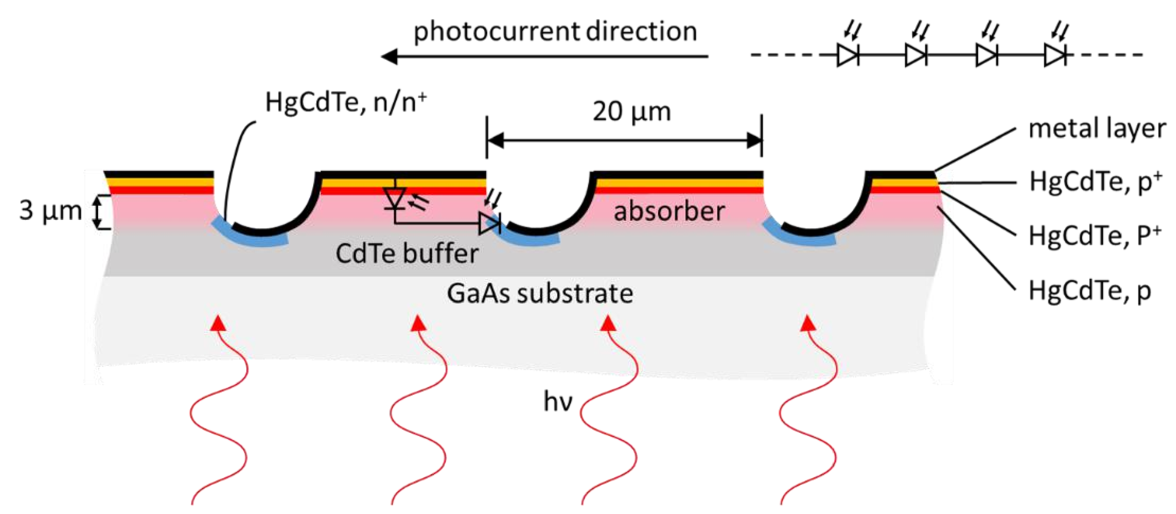

Figure 3. Schematic cross-section in plane perpendicular to the mesa stripes & trenches (Figure 4) of a portion of the PVM periodical structure within a pixel.

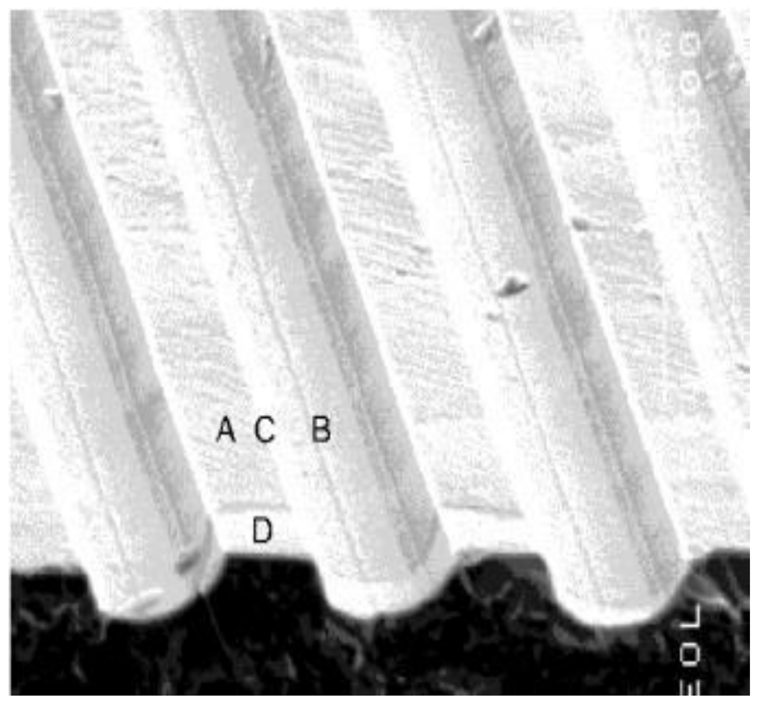

Fig. 4. SEM image side view of a PVM periodical structure surface: A - photoactive mesa structure – photovoltaic cell, B - trench, C - non-metalized wall, D - non metalized region of the device

RESULTS

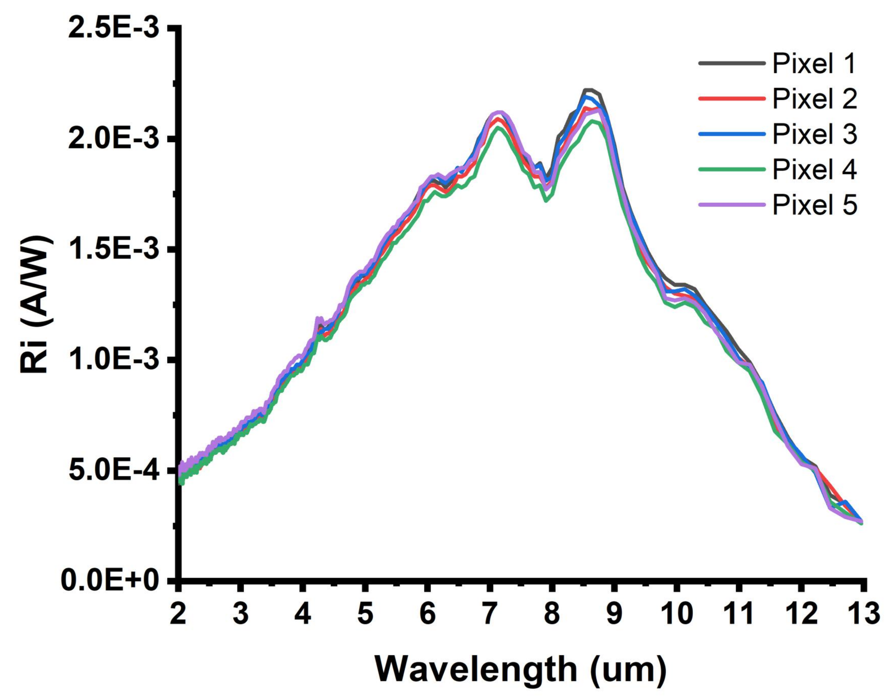

Fig. 5. Low frequency spectral characteristics of individual pixels.

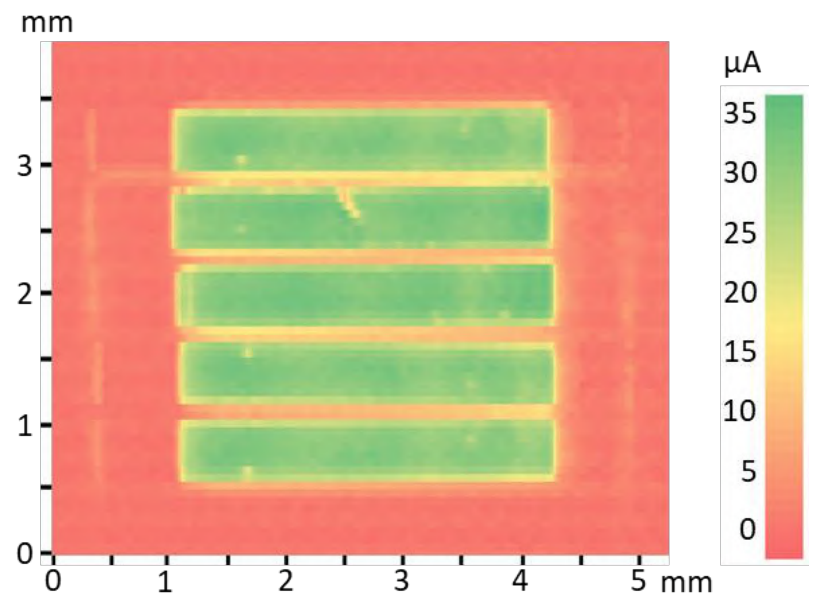

Fig. 6. Map of photo-signal, as result of scanning using CW 3 um laser spot of Gaussian like radiation distribution with 1/e2 dia 260 um.

CONCLUSIONS

The introduced photodetector is made of a series of HgCdTe photodiodes which are uncooled, UV-visible-blind. It has a photoresponsivity of $>5x10^{-4}$ A/W with a peak value of $>2x10^{-3}$ A/W in the range of 7 to 9 µm. Adding varieties of optical filters can also open opportunities to use the detector for portable micro-spectrometer applications.

The proposed photodetector can extend the inspection range up to 12 µm. This extension brings some new capability of measuring unbalanced local temperature in critical optical components.

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