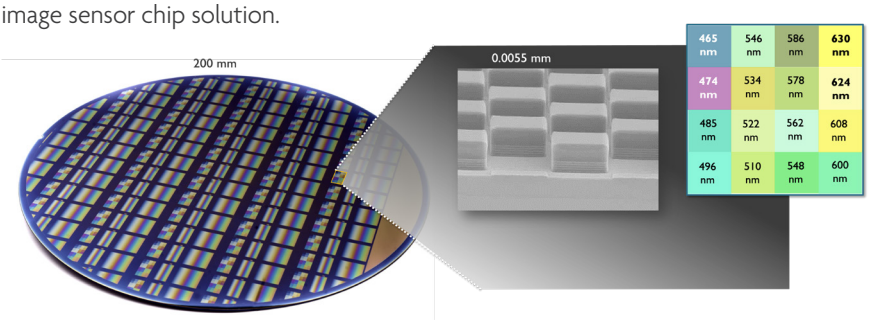
imec
embracing a better life

Compact on-chip spectral imaging for space

Traditionally, spectral imaging from space was limited to specialized scientific missions using large and complex instrumentation. However, with the groundbreaking advancements in spectral imaging technology, compact cameras can now be mounted on small satellites and space exploration vehicles. This makes it possible to unlock a treasure trove of valuable data, which can be translated into information related to water content, specific minerals, vegetation health etc. on the earth or other planets.

On-chip optical filters for compact multi-and hyperspectral payloads

Imec has developed a unique technology in which spectral filters are deposited and patterned directly on top of standard CMOS image sensors. This monolithic integration approach combines extreme miniaturization advantages (as compared to prism and grating-based systems) with the ease of integration of a complete spectral image sensor chip solution.



Key benefits

- Compact, robust and lightweight spectral camera
- Digital time-delay-integration (TDI) for enhanced signal-to-noise ratio at high resolution
- Precise filter to detector alignment for efficient use of the focal plane and high-quality sensing
- Wide spectral range from 400 to 2500nm (VIS, NIR, SWIR)
- Snapshot, video-rate and scanning spectral imaging
- Flexibility in design and tune spatially variable filter to a specific application
- Easy integration at application level

Applications

Earth observation from small satellites

The rise of lower-cost miniaturized satellites, with short revisit times, is transforming earth observation. Just think what a spectral payload on these satellites could mean for precision agriculture, geology, environmental monitoring, archaeology, pollution monitoring and surveillance. Imec's spectral technology is contributing to this new era in which the earth is being monitored at high temporal, spatial and spectral resolution.

Applications

Space exploration on rovers and robots

Spectral imaging technology can be used to equip space explorers and robots with the ability to create highly detailed maps, study the composition of a planet's atmosphere, pinpoint the presence of specific minerals, and investigate the conditions necessary for life. Again, the compactness and robustness of the spectral payload is of great importance for this application. The spectral imaging snapshot capability is a perfect match with this environment which is typically facing severe data communication restrictions.

Fabrication in state-of-the-art infrastructure

Imec has a strong background in semiconductor fab, equipment and process technology and uses it to design and manufacture spectral filters at wafer level, deposited and patterned directly on top of image sensor pixels. This unique CMOS-based infrastructure provides very compact, robust, clean and high-yield optical filter integration with scalability to high-volume and low cost.

The precision of our lithographic process enables a monolithic approach with unparalleled flexibility in depositing individual filters at the single-pixel level, fabricating highly optimized geometric filter layouts with minimized losses due to transition zones. It avoids doing a tedious alignment step between detector array and an external optical filter substrate. It opens new opportunities to optimize the filter design for mage post-processing or compressed sensing

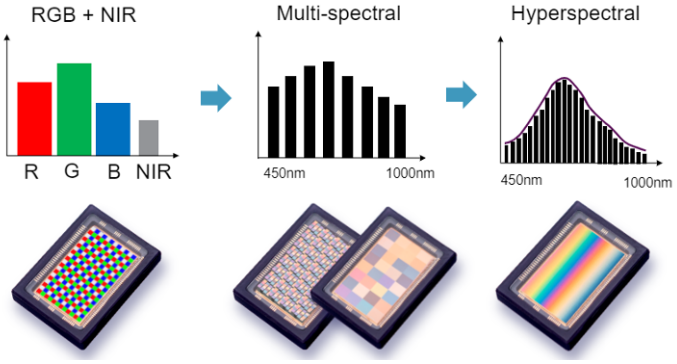
Fabry-Pérot filters

The basic architecture of imec's on-chip filters are the Bragg reflectors. These are a multiple layer stack of alternating high and low refractive index materials and are the basic building block of the Fabry-Perot filter, which consist of two Bragg mirrors separated by a transparent cavity. The reflectivity of the Bragg mirrors defines the spectral range, the Full Width Half Max (FWHM) and the quality of the filter. The cavity thickness defines the central wavelength of the optical filter.

Flexibility in spectral filter layouts

Due to the flexibility of the lithographic patterning process, different types of filters can be made, enabling spectral cameras with different capabilities, e.g. linescan or snapshot.

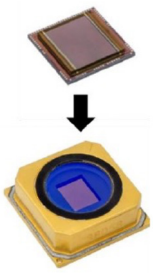
In line-based patterns, several complete detector lines correspond with one single filter to allow TDI-operations to boost signal to noise ratios. Another type are the mosaic patterns with for instance 4x4 or 5x5 matrices of unique filters repeated over the detector allowing to also operate the sensor in real-time video mode. This is advantageous for space exploration with roves and robots to monitor dynamic scenes with reduced data through-put.



From application specs to packaged spectral detector

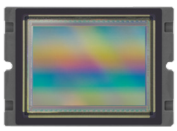
Imec is a world-leading R&D and innovation hub, developing technologies that are 3 to 10 years ahead of industry. Working with imec, you thus have access to the most advanced technologies and capabilities. Still, other than with university labs, imec has a strong link to industry and focuses on manufacturability of its technologies.

In the domain of spectral imaging, imec provides off-the-shelf sensors which are ideal for evaluating the technology for specific use cases. Next, imec also provides fully customized space-compatible sensing solutions, including the full integration, testing, and characterization.



InGaAs FPA with imec glass filter integrated on top

After packaging sealed and purged package



Example of a complete linescan system LS 150

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