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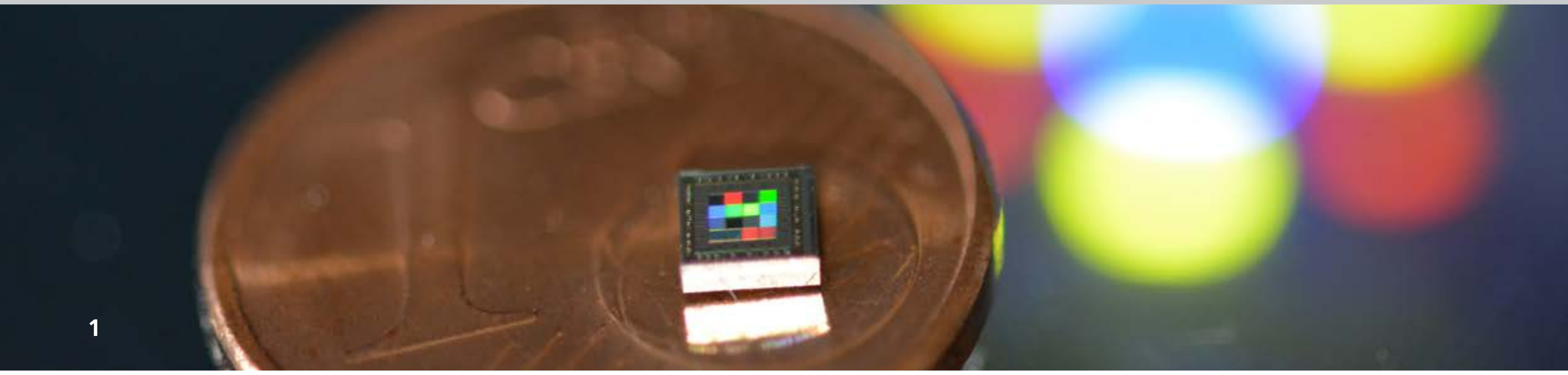

1 *Chip prototype with 12 spectral channels*

NANOSPECTRAL COLOR FILTERS IN CMOS

We develop color and multispectral sensors for specific applications. To capture the spectral characteristics of light, we use optical nanostructures in the metal layers of CMOS processes. Color and multispectral filters can be produced with no need for subsequent production steps. Being a very cost effective way of generating optical filters it is furthermore possible to implement hundreds of spectral channels without additional processing costs.

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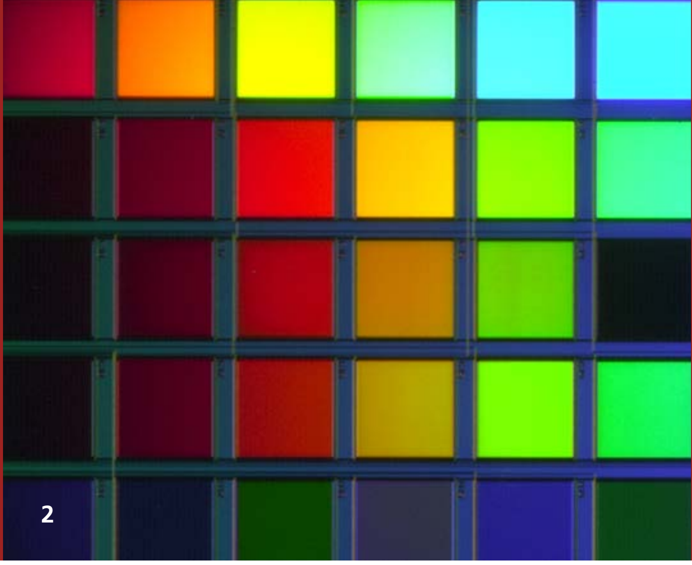
Features

- Realization of multiple spectral channels on a chip in with only 2 additional photolithographic process steps
- Metal filter material
- Straightforward design of specific spectral behaviour
- Applicable to existing light or image sensors
- Implemented in two different commercial CMOS foundries

Benefits

- Single source fabrication
- Constant processing costs for arbitrary number of spectral channels
- Temperature stability
- No drift or ageing
- Application-specific filter performance
- Easy transfer to standard products
- Independent design service and supply chains
- Fast transfer to series production



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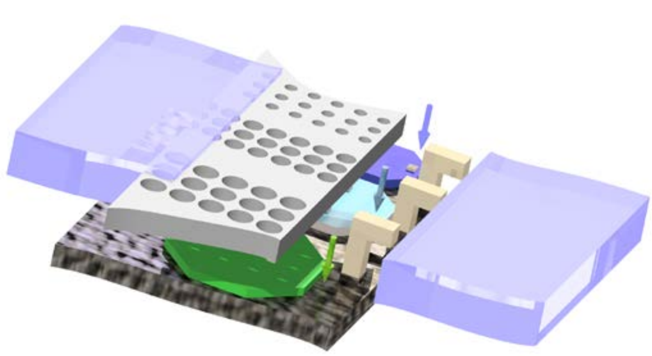

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General Characteristics

- Wavelength range 300-1000 nm
- Transmission typically 50 %
- Patterning of metal layers as on-chip filters
- Plasmonic and other subwavelength structures

As opposed to thin film filter technology, the number of layers does not increase with an increasing number of spectral channels. Tailored pass bands of the filters are achieved by modifying the lateral geometry of the nanostructures only.

The potential cost reduction offered by the technology is depicted in the graph below: Currently the number of spectral channels in low cost products is limited to typically 6 because processing costs are proportional to the number of spectral filter channels. Grating based spectrometer technologies on the other hand can not benefit from scaling effects as known from CMOS products. The nanoSPECTRAL technology bridges the gap and offers spectrometer-like performance at very low costs.

Applications and Technology Potential

LED monitoring and control for human centric lighting, smart greenhouse or automotive lighting

- Multispectral ambient light sensors
- More spectral information compared to sensors with three channels (RGB or XYZ)
- Adjusting LED lighting to achieve target color temperature or spectral composition
- Integrated signal processing and standard interfaces like I2C or SPI

Low Cost Chip Size Spectrometer

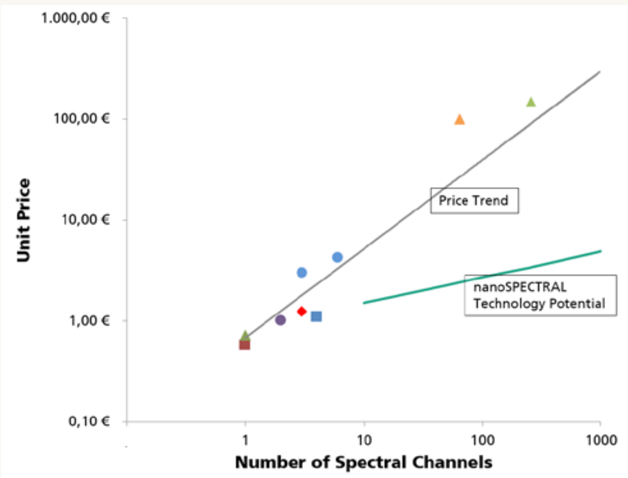
- Miniaturized multispectral sensors for analyzing gases and liquids
- Color sensors for industrial automation and automotive applications
- Agriculture and smart farming
- Food analysis and quality control
- Medical applications (point-of-care)
- Number of spectral channels: 100-1000
- Full width at half maximum (FWHM): 10-50 nm

Low Cost Multispectral Imaging

- Image sensors with spectral filters on pixel level
- Application of filters to established standard products or new image sensor designs
- Minimum pixel size: 5 µm

Highly Accurate Optical Angle Encoders

- Nanostructured wire grid polarizers
- High resolution angular decoders
- Angle accuracy down to 0.01°



Distribution prices (1000 pcs.) of different multispectral sensor products and potential product costs by using the nanoSPECTRAL filter technology

2 Section of filter array © Fraunhofer IIS

3 Schematic drawing of substrate, photodiodes and plasmonic filter structure © Fraunhofer IIS / Wladimir Tschekalinskij