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Waveguide-based color splitters for next-gen image sensors

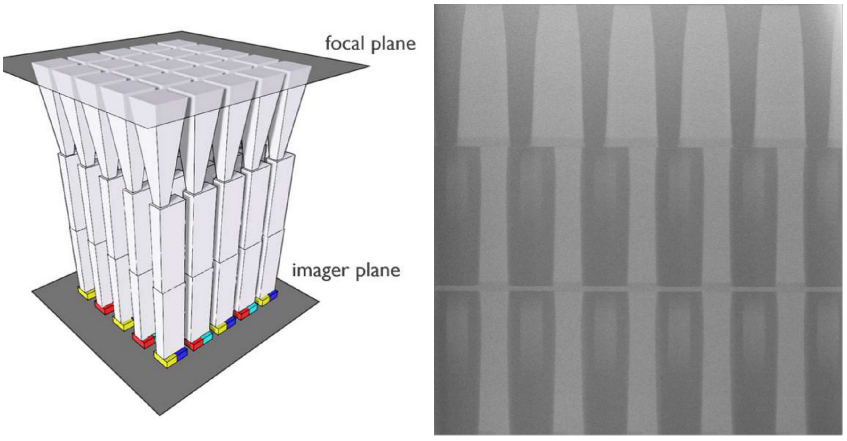
Imec has developed an innovative color-splitting technology, providing an alternative to the traditional absorptive Bayer filters found in smartphone and digital camera image sensors today. This innovation will enable significant improvements in sensitivity and resolution, addressing the limitations posed by scaling phenomena of pixels, color filters and microlenses.

Color image sensors have seen a tremendous evolution with ever smaller pixel sizes – the smallest being 0.5µm – and thus increased resolution. However, this path has reached its limits. One of the problems is that the Bayer color filters absorb 70% of the incoming light which, with small pixels, becomes an issue, decreasing substantially the signal-to-noise ratio.

New technology for splitting colors

The new technology uses vertical waveguides to split the incoming light according to its color towards the pixels. By using these waveguide-based color splitters instead of color filters, every photon of the scene is detected by the image sensor pixels. This makes it possible to further scale the pixels below the diffraction limit. Some details on the new technology:

- Standard back-end-of-line process on 300mm wafers
- Si3N4 waveguides in SiO2 on glass
- Application of wavelength-dependent dual-mode beating
- Tunable color splitting via geometry
- Replaces color filter and microlens arrays
- Compatible with high numerical aperture camera lenses



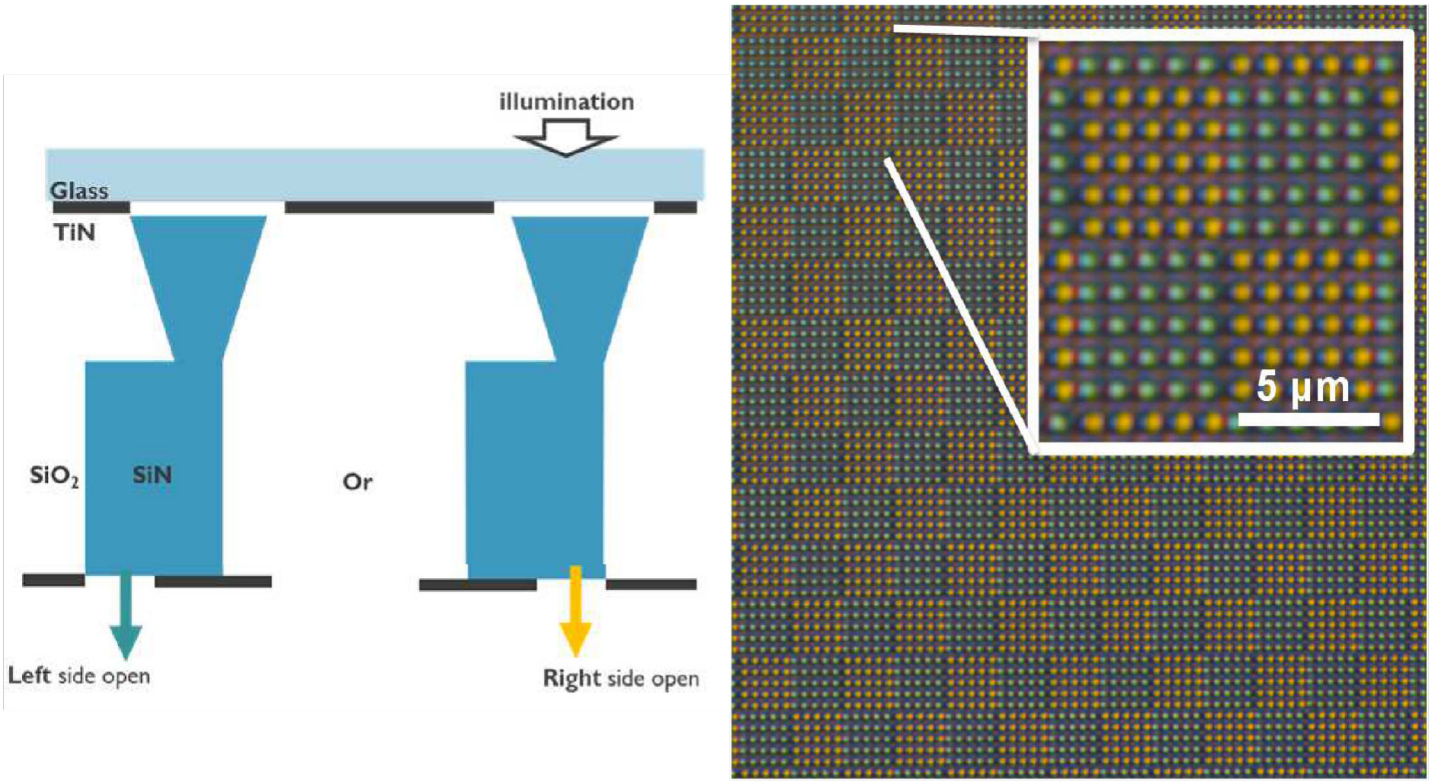
3D visualization (left) and TEM cross-section (right) of the vertical waveguide array for color splitting in BY-CR imaging.

Advantages

- Overcome diffraction limited small pixel sizes
- Increase effective low-light resolution
- > 90 % broadband transmittance
- Exceptional color accuracy (Vora value > 95%)

Imager markets

- Smartphone
- Automotive
- Endoscopy



RGB camera measurement (100x magnification) of an array of waveguides with alternating 5 left-side-open-aperture and 5 right-side open-aperture (the others being occluded by TiN) waveguides at a 1-micron pitch. Yellow light exits at the right part of the waveguide, whereas the blue exits at the left. The wafer is illuminated using plane wave white light.

Imec.xpand is working towards incorporating this technology into a start-up venture.

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